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SECTION 02100

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## SECTION 02100

## DIVERSION AND CONTROL OF WATER

## PART 1 GENERAL

## 1.1 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-01 Preconstruction Submittals

Diversion and Control of Water Plan; G, RE.

Plan describing the proposed methods to protect each construction work areas from storm runoff.

## 1.2 REQUIREMENT

## 1.2.1 General

All permanent construction shall be carried on in areas free from water. Water in varying quantities may be flowing in natural washes throughout the length of the project, as a result of rainfall or flow from upstream watersheds sources. Storm runoff from watersheds can be rapid and, during periods of rain, flash flooding may be expected. The project consists of improvements to a natural drainage course.

Within 10 days after receipt of Notice to Proceed, the Contractor shall submit a Diversion and Control of Water Plan showing the method that he proposes to use to divert water from each working area. In addition, the Contractor shall indicate:

- a) The order of work proposed to provide a continuous flood drainage system during construction.
- b) Related or conflicting items of work necessarily requiring coordination and/or staged construction, particularly involving maintenance of traffic through the area of channel crossing at Rainbow Blvd, Tioga Way, and Buffalo Drive, and construction of the parallel detour roads.

The responsibility for damage to any part of the permanent work shall be set forth in the CONTRACT CLAUSE: PERMITS AND RESPONSIBILITIES. Damage all work (including temporary construction), utilities, materials, equipment,

and plant shall be repaired to the satisfaction of the Contracting Officer at the Contractor's expense, regardless of the of such damage.

#### 1.2.2 Diversion Requirements

The Contractor is responsible for the diversion and control of all runoff entering the construction area. The runoff will include water originating from upstream, urban runoff, adjacent drainages; and in addition any and all seepage and groundwater originating within the work. The work site may be inundated because of runoff. The Contractor shall be responsible for protection of work site during times of runoff by his own means and shall be approved by the Contracting Officer.

#### 1.2.3 Drainage Ditches

The location and depth of any drainage ditch to be constructed under this contract shall be subject to the approval of the Contracting Officer. Special precautions shall be taken to avoid impairing the permanent subgrade. Damaged subgrade shall be replaced in accordance with SECTION 02300 EARTHWORK by and at the expense of the Contractor.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

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## SECTION 02230

## CLEAR SITE AND REMOVE OBSTRUCTIONS

## PART 1 GENERAL

## 1.1 DEFINITIONS

## 1.1.1 Clearing

Clearing shall consist of the felling, trimming, and cutting of trees into sections and the satisfactory disposal of the trees and other vegetation designated for removal, including down timber, snags, brush, and including the removal of debris piles (consisting of construction debris and/or dumped soils, dumped gravels, dumped rocks and dumped boulders), and rubbish and/or trash and vehicle debris (vehicle bodies and/or vehicle parts) occurring in the areas to be cleared.

## 1.1.2 Grubbing

Grubbing shall consist of the removal and disposal of stumps, roots larger than 75 mm in diameter, and matted roots from the designated grubbing areas.

## 1.2 SUBMITTALS (NOT APPLICABLE)

## 1.3 ENVIRONMENTAL PROTECTION

All work and Contractor operations shall comply with the requirements of Section 01355 ENVIRONMENTAL PROTECTION and Section 02300 EARTHWORK.

## 1.4 BURNING

The use of burning at the project site for the disposal of refuse and debris will not be permitted.

## PART 2 PRODUCTS (Not Applicable)

## PART 3 EXECUTION

## 3.1 REQUIREMENTS

## 3.1.1 General

Except as otherwise specified, and/or indicated, areas to be cleared will be limited to actual excavation areas, and areas on which fills and/or structures are to be placed. The removal of trees, shrubs, turf, and other vegetation outside of these areas shall be held to a minimum and care shall be exercised not to damage any trees, shrubs, turf, or vegetation which can be left in place.

### 3.1.2 Existing Structures and Obstructions

The Contractor shall clear and grub areas of fill and excavation, and remove and dispose of existing structures and obstructions necessary for project construction, except for those structures which are identified to be protected in place as shown on the drawings.

### 3.2 CLEARING

All rubbish, waste dumps, and debris areas shall be cleared. Vegetation including grasses, shrubs and weeds shall be removed by grading the existing ground surface to a depth of 0.15 meters, except such vegetation as may be indicated or directed to be left standing. Vegetation to be left standing shall be protected from damage incident to clearing, grubbing, and construction operations by the erection of barriers or by such other means as the circumstances require. Clearing shall also include the removal and disposal of structures that obtrude, encroach upon, or otherwise obstruct the work.

### 3.3 GRUBBING

Grubbing shall consist of removing non-salvaged roots larger than 75 mm in diameter, matted roots, and other objectionable vegetable matter in the required fill areas, foundation areas, and all excavation areas. In grubbing roots, 610 mm diameter roots shall be removed to below the depth of the required excavation or existing ground level, whichever is lower. Depressions made by grubbing shall be filled with suitable material and compacted to make the surface conform with the original adjacent surface of the ground.

### 3.4 Trash and Construction Debris

Surface trash and construction debris may be present at the project site. Surface trash and construction debris shall be removed from within the limits of the right-of-way and temporary construction easements. This includes the removal of debris piles (consisting of construction debris, minor construction equipment abandoned, and/or dumped soils, dumped gravels, dumped rocks and dumped boulders), and rubbish and/or trash and/or vehicle debris (vehicle bodies and/or vehicle parts) and/or appliance debris (whole or parts) occurring in the areas to be cleared.

### 3.5 Environmental Assessment Requirement

The Contractor shall notify the Contracting Officer 14 calendar days prior to the start of clearing and grubbing activities in accordance with Section 01200 GENERAL REQUIREMENTS, Paragraph ENVIRONMENTAL ASSESSMENT REQUIREMENT.

### 3.6 DISPOSAL OF GRUBBED AND REMOVED MATERIAL

Trash, construction debris, debris piles, rubbish, vehicle debris, appliance debris and material from grubbing, that is designated as scrap, shall become the property of the Contractor, and shall be removed from the site. Scrap and unsatisfactory soils and materials and unstable soils and materials as described in Section 02300 EARTHWORK, paragraph DISPOSITION

AND DISPOSAL OF EXCAVATED MATERIALS, shall become the property of the Contractor, and shall be removed from the site. Disposal shall be in accordance with the requirements of Section 01355 ENVIRONMENTAL PROTECTION.

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## SECTION 02300

## EARTHWORK

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## U.S. ARMY CORPS OF ENGINEERS (USACE)

COE EM 385-1-1 (1996) Safety and Health Requirements Manual

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 422 (1963; R 1998) Particle-Size Analysis of Soils

ASTM D 1556 (2000) Density and Unit Weight of Soil in Place by the Sand-Cone Method

ASTM D 1557 (2000) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu.m.))

ASTM D 2216 (1998) Laboratory Determination of Water (Moisture) Content of Soil and Rock

ASTM D 2487 (2000) Classification of Soils for Engineering Purposes (Unified Soil Classification System)

ASTM D 2922 (1996e1) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

ASTM D 4914 (1994) Density of Soil and Rock in Place by the Sand Replacement Method in a Test Pit.

ASTM D 5030 (1994) Density of Soil and Rock in Place by the Water Replacement Method in a Test Pit.

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The "RE" designates that the Resident Office will review the submittal for the Government. Submit the following in accordance with Section 01330, SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Excavation Plan; G, RE.

The Contractor shall submit his excavation plan to the Contracting Officer in conformance with paragraph EXCAVATION PLAN

Haul Route Plan; G, RE.

The Contractor shall submit a haul route plan for removal of required excavated materials and for placing required fill materials.

SD-02 Shop Drawings

Shop Drawings; G, RE.

The contractor shall submit for approval shop drawings showing the proposed method of bracing which he intends to use to protect existing property.

Explosive Storage Location; G, RE.

The contractor shall submit to the Contracting Officer drawings showing the location, access to and type of construction of the proposed storage magazine for explosives, and cap house.

Pre-construction topographic survey of the entire project site.

The contractor shall submit to the Contracting Officer pre-construction surveys of the entire project site shown on the drawings.

Post-construction topographic survey of the entire project site.

The contractor shall submit to the Contracting Officer post-construction surveys of the entire project site for each of the compacted fill work and the stockpiled filled work shown on the drawings.

SD-05 Design Data

Blast Data Report.

The Contractor shall submit Pre- and Post-Blast Reports which shall contain all of the pertinent data on the location by station, ground surface elevation in the area of the blast; diameter, spacing, depth, over-depth, pattern and inclination of blast holes; the type, strength, amount, distribution and powder factor for the explosives to be used and actually used per hole and per blast; the sequence and pattern of delays, and

description and purpose of special methods.

#### SD-06 Test Reports

Field Density Tests; G, RE.

Treating of Compacted Fill Materials; G, RE.

Copies of all laboratory and field test reports shall be submitted to the Contracting Officer on approved forms within 24 hours of the completion of the tests.

### 1.3 DEGREE OF COMPACTION

Degree of compaction shall be expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557.

### 1.4 DEFINITION OF UNSATISFACTORY MATERIALS

Unsatisfactory materials include but are not limited to those materials containing roots and other organic matter, trash, debris and materials classified in ASTM D 2487, as Pt, OH, OL, CH, MH, and materials too wet to support construction equipment.

## PART 2 PRODUCTS

### 2.1 SOIL STABILIZER PRODUCT

The dust palliative/soil stabilizer shall be a mixture of plaster and natural fiber mulch. The cellulose fiber mulch shall be produced from grinding clean whole wood chips, or fiber produced from ground newsprint with a labeled ash content not to exceed 7 percent. The plaster shall consist of naturally occurring high purity processed gypsum and additives. The gypsum shall be produced from a mined or quarried source. The gypsum shall be processed to be composed of crushed dry calcium sulfate hemihydrate having a purity of not less than 88 percent. The shipping invoices for the gypsum shall state the gypsum's purity content, dry weight, and source of manufacture. Processed gypsum that has become partially air set, lumpy, or caked shall not be used. The Contractor shall add a color pigment to the dust palliative/soil stabilizer slurry at the time of application. Apply color pigment to match existing soil color at the site, at the application rate recommended by the manufacturer. Color can be matched using the "Davis Colors" chart by Soil-Tech, Las, Vegas, Nevada, or equal. The gypsum and additives shall be furnished either in bags or bulk and be accompanied by bills of lading and shipping invoices. The plaster/cellulose fiber mulch shall be applied at a rate of 6.75 tonnes of plaster mixed with 2.242 tonnes of fiber per hectare.

## PART 3 EXECUTION

Prior to the start of construction work (including clear site and remove obstructions, the Contractor shall conduct a pre-construction topographic survey of the entire project site in accordance with Section 01200 GENERAL

## REQUIREMENTS paragraph CONTRACTOR'S SURVEYS.

At the end of all work associated with this section, the Contractor shall conduct a post-construction topographic survey of the entire project site in accordance with Section 01200 GENERAL REQUIREMENTS paragraph CONTRACTOR'S SURVEYS.

## 3.1 EXCAVATION, GENERAL

Excavation shall consist of the removal of every type of material encountered in the designated areas or from areas directed. The material to be removed may include but is not limited to hardpan, silt, sand, gravel, cobbles and boulders, cemented silt/sand/gravel/cobbles/boulders with various degrees of cementation, caliche, asphalt, vegetation, trash, and other debris. Slope lines indicated on the drawings for temporary cuts do not necessarily represent the actual slopes to which the excavation must be made to safely perform the work. Unforeseen conditions may dictate that the temporary cut slope shall be made to the actual slope to which the work can be safely performed. Measurement and payment for excavation will be made in accordance with Section 01270. Excavation for permanent cuts shall be made to the slope lines indicated. Excavation will likely require ripping or other rock-excavation techniques, which may include blasting, and shall be performed in a manner which will not impair the subgrade. Use of heavy tractors equipped with a ripper tooth, hoe-rams, and hydraulic or pneumatic rock breaker could be necessary to excavate highly cemented soils. Rock or cemented material from required excavation to be used in compacted fills and backfills shall be crushed or otherwise reduced in size to meet gradation requirements prior to placement or stockpiling. Except as otherwise specified, the finish surface of subgrades shall be smooth and shall not vary more than 25 mm from indicated grade, except at areas to receive concrete where finished surfaces of subgrade shall not vary more than 12.5 mm from indicated grade. Prior to commencing excavation, the Contractor shall submit his Excavation Plan to the Contracting Officer. All subgrade excavations will be inspected by the Contracting Officer prior to placement of any fill materials.

## 3.1.1 Excavation Plan

Prior to commencing excavation, the Contractor shall submit his plan for excavation to the Contracting Officer for acceptance. The plan must show all proposed locations of excavation operations utilizing methods involving blasting, headache balling, hoe ramming, or other techniques as may be applicable. In addition, the plan must include the results of a pre-excavation survey, a detailed blasting plan (if applicable) performed by a certified blasting consultant, and a seismic monitoring plan. The excavation plan shall be updated and resubmitted to the Contracting Officer any time the Contractor proposes altering his methods. The Contractor's methods for excavation are solely his responsibility. Approval of the excavation plan by the Contracting Officer will in no way limit the Contractor's liability regarding property damaged by this operations, nor will it alter the Contractor's sole responsibility for the safety of his operations. The Contractor shall be responsible for all damage caused by his excavation operations and be responsible for answering all complaints. The Contractor shall provide the Contracting Officer with 30 days advance

warning of the use of excavation techniques which may lead to property damage to allow for review of the proposed techniques, to confirm general compliance with these specifications, and to allow monitoring of the excavations methods.

### 3.2 EXCAVATION, BLASTING

Any method used to excavate the structure or channel using explosives shall be subject to the approval by the Contracting Officer.

#### 3.2.1 General Requirements

The drilling and blasting program and methods shall be the minimum necessary to break up the rock and/or caliche/cemented alluvium into bulldozer-manageable sized pieces for removal. Only the minimum strength explosive that will accomplish the fracturing will be allowed. If multiple charges are deemed necessary, they will be sequenced to produce good breakage of the rock or caliche/cemented alluvium and reduce airblast (sonic impacts) and ground vibrations to minimal levels. In the design of the blasting pattern, no blastholes will be permitted within 60 meters of an active tortoise or Gila Monster burrow. A qualified desert tortoise ecologist is required to be present during all blasting operations to ensure that there are no occupied burrows and/or to remove tortoises or Gila Monsters from the surface or burrows within the 60 meter limit. The desert tortoise ecologist will provide a short report with field notes to the Contracting Officer. The desert tortoise ecologist will be provided by the Contractor as his own expense. Additional restrictions may be imposed during the hibernation period (15 November through 15 March) to protect hibernating tortoises, if necessary and directed by the Contracting Officer. The Contractor shall strictly comply with all State and local regulations regarding construction blasting (e.g., Uniform Standard Specifications for Public Works Construction Off-Site Improvements, Clark County Area, Nevada, Third Edition, subsections 107.10, 203.03.03, and 208.03.01, and Engineer Manual (EM) 1110-2-3800, including all notice and reporting requirements). Under no circumstances shall blasting be performed within 30 meters of concrete that has been placed less than seven days. Blasting within 30 meters of concrete older than seven days will be permitted only if approved by the Contracting Officer.

#### 3.2.2 Blasting

Prior to drilling for each blast, the Contractor shall submit a Pre-Blast data report plan on an approved form, which includes the pertinent data on the location by station, ground surface elevation in the area of the blast; diameter, spacing, depth, overdepth, pattern and inclination of blast holes; the type, strength, amount, distribution and powder factor for the explosives used per hole and per blast; the sequence and pattern of delays, and description and purpose of special methods. The loading of holes shall be done in the presence of a Government inspector. Acceptance by the Contracting Officer of the Pre-Blast data report plan will not relieve the Contractor of his sole responsibility to produce satisfactory results as set forth in these specifications. Drilling and blasting shall be done only to the depth, amount, and at such locations, with explosives of such quantity, distribution and density that will not produce unsafe or damaged

rock and/or caliche/cemented alluvium surfaces or damage beyond the prescribed excavation limits. When a drilling and blasting program results in damage to the excavation, or to natural or man-made features, or is injurious to wildlife and habitat, the Contractor will be required to devise and employ methods which will prevent such damage. The revision may include special methods such as presplit and zone blasting, shallow lifts, reduction in size of individual blasts, small diameter blast holes, closely spaced blast holes, reduction of explosives, greater distribution of explosives by use of decking and primacord or variation in density of explosives.

#### 3.2.2.1 Blasting Nearby Structures and Utility Lines

Blasting will not be permitted close to the existing structures and utility lines. Contractor shall use other rock excavation techniques, and deploy all means necessary to break-out and remove layers of highly cemented soils nearby the structures and utility lines. Contractor shall coordinate with utility owners prior to excavation and blasting in the vicinity of utility lines.

#### 3.2.3 Overshooting

The Contractor shall use controlled blasting techniques so as not to overshoot. All possible care shall be exercised in drilling and blasting operations to prevent formation of discontinuities and to minimize over-break and blast damage of adjacent unexcavated ground and structures. Any material outside the authorized limits which may be shattered or loosened because of blasting shall be removed and/or re-compacted by the Contractor at his expense. Shattered or loosened material below the bottom limits of the required excavation shall be uniformly distributed and compacted or otherwise disposed of in a manner satisfactory to the Contracting Officer. The Contractor shall discontinue any method of blasting which leads to overshooting or is dangerous to the public, destructive of natural or man-made features, or is injurious to wildlife and habitat.

#### 3.2.4 Pre-excavation Survey

The Contractor shall perform a pre-excavation survey which shall include as a minimum; detailed examination of adjacent structures, including video taping and installation of crack monitoring tape along existing structural cracks. Also included shall be a seismic survey performed by a certified seismic survey firm to determine limiting charge weights, distances to structures, ect. for all areas where blasting is proposed and limiting ball weights, height of drop, etc., for all areas where headache balls and/or hoe ram techniques are proposed.

##### 3.2.4.1 Vibration Monitoring

During construction, the Contractor shall hire a certified seismic survey firm to perform a seismic monitoring program to determine the effects of any blasting, headache ball or hoe ram use, or any other specialized excavation technique. Particle velocities measured at an existing structure or 300 meters from the blasting, which ever is closest, shall not



exceed statutory limits or 12.5 millimeters per second (whether the result of blasting or other excavation technique). In addition to these requirements, the Contractor shall provide suitable vibration monitoring equipment to measure and record ground motions at the 60 meter distance.

#### 3.2.5 Notifications

The Contractor shall notify each property owner and public utility company having structures or facilities in proximity to the site of the work of his intention to use explosives. Such notice shall be given sufficiently in advance to enable the companies to take such steps as they may deem necessary to protect their property from injury. Any blasting adjacent to or crossing existing utilities shall be fully coordinated with the owner of the effected utility to include hole spacing, loading and vibration.

#### 3.2.6 Qualifications

During blasting operations, the Contractor shall have on site, and in immediate charge of the blasting, a licensed blaster acceptable to the Contracting Officer who has had no less than 3 years of experience in controlled blasting and rock excavation operations. Powder handlers shall have had no less than one year continuous experience in preparation and loading of powder charges.

#### 3.2.7 Post-Blast Data Reports

In addition to the reporting requirements required above, a separate Post-Blast Data Report of each blast shall be prepared and furnished to the Contracting Officer on an approved form. The report shall indicate the location of the blast by specific stationing, ground surface elevation, depth of round, pounds of explosives used by type and grade, total number of loaded holes, total pounds per delay, quantity and kind of explosive in each hole, maximum measured blast vibration, and all other blast information directed by the Contracting Officer. Original or legible copies of the report shall be provided to the Contracting Officer within 24 hours of the blast event.

#### 3.2.8 Explosives

##### 3.2.8.1 Safety

The contractor shall fully comply with Section 29, Blasting, COE EM 385-1-1 and any Local or State Laws and Regulations applicable to the proposed Blasting Plan.

##### 3.2.8.2 Storage

The Contractor shall submit to the Contracting Officer, for approval, drawings showing the explosive storage location, access to and type of construction of the proposed storage magazine for explosives, and cap house. The explosives storage magazine and other facilities may be located on project lands if a satisfactory location can be found and is approved by the Contracting Officer. The Contractor shall maintain the explosive storage area at his own expense. The explosives storage magazine shall be

securely locked when not in use.

### 3.3 PRESERVATION OF PROPERTY

All excavation operations shall be conducted in such a manner that concrete structures, embankments, utilities, or other facilities and improvements which are to remain in place permanently will not be subjected to settlement or horizontal movement. The Contractor shall furnish and install sheet piling, cribbing, bulkheads, shores, or whatever means may be necessary to adequately support material carrying such improvements or to support the improvements themselves and shall maintain such means in position until they are no longer needed. Temporary sheet piling, cribbing, bulkheads, shores or other protective means shall remain the property of the Contractor and when no longer needed shall be removed from the site. The Contractor shall submit for approval shop drawings showing proposed method of bracing which he intends to use. All shoring and bracing shall be designed so that it is effective to the bottom of the excavation, and shall be based upon calculation of pressures exerted by (and the condition and nature of) the materials to be retained, including surcharge imparted to the side of the trench by equipment and stored materials. Removal of shoring shall be performed in such manner as not to disturb or damage the finished concrete or other facility.

### 3.4 EXCAVATION FOR STRUCTURES

Excavation within the vicinity of existing structures, utilities, roads, and drainage pipes to remain in place shall be performed in a manner to prevent damage to the structure. Earth banks and facilities to remain in place shall be supported as necessary during excavation. Potential for damage resulting from severe vibration may limit the Contractor's operations or choice of equipment. In general, unless otherwise shown or specified, the actual side slopes shall be in accordance with COE EM 385-1-1.

### 3.5 EXCAVATION CHANNEL

Channel excavation consists of the removal of all materials within the lines and grades indicated.

### 3.6 REMOVAL OF UNSATISFACTORY MATERIALS

The removal of unsatisfactory materials which are unsatisfactory for the foundation of the channel, or other structures, may be required in certain areas. For definition of unsatisfactory materials see paragraph: DEFINITION OF UNSATISFACTORY MATERIALS. Channel subgrade materials that cannot be brought to 95% compaction after scarification, shall be removed. The Contractor will be required to excavate any such areas to the depth directed and backfill the removal areas with compacted fill conforming to the requirements of Paragraph GENERAL REQUIREMENTS FOR COMPACTED FILLS AND COMPACTED BACKFILLS.

### 3.7 DISPOSITION AND DISPOSAL OF EXCAVATED MATERIALS

Excavated materials suitable for required fills shall be placed in temporary stockpiles or used directly in the work. Excess satisfactory

excavated material that are not utilized as part of the shall be processed as necessary, hauled and placed in the designated disposal site. Material to be placed in disposal site shall be free from trash, debris, and hazardous substance. Materials characterized as unsatisfactory soil including trash, dumped debris and demolition products and materials suspected of having characteristics of hazardous and/or toxic waste shall become the property of the contractor and shall be removed from the project site in accordance with requirements Section 01355 ENVIRONMENTAL PROTECTION and Section 01200 GENERAL REQUIREMENTS. No excavated material or waste of any kind shall be removed beyond the project limits under this contract without the express written authority of the Contracting Officer. Prior to placing material, the approved stockpile area(s) shall be cleared of trash and vegetation. Vegetation shall be removed by grading the existing ground surface to a depth of 150 mm. Any stockpiles shall be placed in a manner to preclude ponding of water. Natural ground and surface soils and materials thus excavated and removed will then be designated as either:

- i. Materials to be salvaged, or
- ii. Scrap and unsatisfactory materials and soils and unstable materials and soils to be treated as specified above and in Section 02230 CLEAR SITE AND REMOVE OBSTRUCTIONS.

#### 3.7.1 Hauled Excavated Material

The Contractor shall have a haul route plan within the project limits, including removal of required excavated materials and placing fill materials and hauling of excess excavated materials. The haul route plan shall be submitted to the Contracting Officer for approval. Haul routes for transport of the excess excavated material shown on the drawing are approximate. The Contractor will be responsible for obtaining all permits and licenses necessary to haul material off-site. The Contractor will provide to the Contracting Officer three copies of the proposed street haul route plan for transport of all excess excavated material.

#### 3.8 OVERCUT

Except as otherwise specified or specifically ordered in writing, any overcut or excavation beyond the lines and grades indicated in the plans (or as directed) shall be backfilled with compacted fill conforming to the Paragraph GENERAL REQUIREMENTS FOR COMPACTED FILLS AND COMPACTED BACKFILLS, or concrete conforming to the Section 03301 CAST-IN-PLACE STRUCTURAL CONCRETE. Subgrades shall be prepared in accordance with paragraph SUBGRADE PREPARATION. The Contractor shall expect to overbuild and trim back the compacted fill required to backfill overcuts made at trapezoidal channel sections. All excavating, backfilling, compacting of backfill, and concreting occasioned thereby shall be by the Contractor at no additional cost to the Government. Any overcut under existing or newly constructed channels and structures shall be backfilled with concrete.

#### 3.9 COMPACTION EQUIPMENT

Compaction shall be accomplished by tamping roller, rubber tired roller vibratory compactor or mechanical tampers. All equipment, tools, and machines shall be maintained in satisfactory working condition at all

times. Compaction equipment shall be suitable for consistently producing uniform soil densities.

### 3.10 GENERAL REQUIREMENTS FOR COMPACTED FILLS AND COMPACTED BACKFILLS

#### 3.10.1 Control

Moisture-density relations shall be established by the Contractor. The soil used for each maximum density test shall be classified in accordance with ASTM D 2487 and shall include a particle size analysis in accordance with ASTM D 422. At least one five point maximum density test shall be made for every 10 field density tests. Field density test shall be performed by the Contractor at the frequency established in paragraph Field Control, and in such locations to insure that the specified density is being obtained. Moisture-density relations and field densities shall be reported on approved forms. One copy of density data less dry weight determinations shall be provided on the day each test is taken. The completed field density tests report shall be provided with the Contractor Quality Control Report on the work day following the test. All data related to the treating of compacted fill materials shall be submitted to the Contracting Officer on approved forms within 24 hours of the completion of the tests.

##### 3.10.1.1 Laboratory Control

Moisture-density relations shall be established by the Contractor. One moisture-density relation shall be made for each classification, blend or change in classification of soil materials encountered. Approval of moisture-density relations shall be obtained prior to the compacting of any material in the work. The moisture-density relations shall be determined in a laboratory in accordance with ASTM D 1557.

- a. The desired amount of mixing water will be added for each compaction test specimen, mixed well, and the mixture will be placed in a container with an airtight cover and allowed to cure for 24 hours. A shorter curing time may be allowed where tests show that shortening the curing time will not affect the results.

##### 3.10.1.2 Field Control

Field in-place density shall be determined in accordance with ASTM D 1556. The field moisture content shall be determined in accordance with ASTM D 2216. Determination of in-place densities using the nuclear method ASTM D 2922 may be used to supplement the sand cone density tests ASTM D 1556. When ASTM D 2922 is used, the calibration curves shall be checked and adjusted using only the sand cone method as described in ASTM D 1556. When material contain considerable amount of rock or coarse gravel in-place density test method ASTM D 4914 or ASTM D 5030 shall be used. At least one adjacent sand cone test shall be performed for every five nuclear density tests performed. If field density tests determined by the nuclear method vary by more than 0.1 kilonewtons per cubic meter from comparison sand-cone tests, and are consistently high or low, adjustment of the calibration curve is necessary.

## a. In-Place Densities

(1) One test per 750 cubic meters, for the first 7,500 cubic meters of material and one test for each 1,500 cubic meters thereafter, or fraction thereof, shall be made of each lift of fill or backfill areas compacted by other than hand-operated machines. At least one test shall be made in each 600 mm layer of compacted fill or backfill processed as a unit and not less than one test shall be made in each area. One test per 300 cubic meters, or fraction thereof, shall be made of each lift of fill or backfill areas compacted by hand-operated machines. The contractor CQC shall maintain a log of all tests, which will, updated and submitted to the contracting officer on a weekly basis. The test log shall include: Test number (if retest shall include retest number), date, feature of work, station and offset, elevation, weight of wet soil, weight of dry soil, percent of compaction, optimum moisture content, maximum dry unit weight, soil classification, in-place density test methods either sand-cone or nuclear densimeter.

(2) One test per 400 cubic meters, or fraction thereof, shall be made of each lift of fill or backfill areas compacted by hand-operated machines. The Contractor CQC shall maintain a log of all tests which will updated and submitted to the Contracting Officer on a weekly basis. The test log shall include: Test number (if retest shall include retest number), date, feature of work, station and offset, weight of wet soil, weight of dry soil, percent of compaction, optimum moisture content, maximum dry unit weight, soil classification, in-place density test methods either sand-cone or nuclear densimeter.

## 3.10.2 Settling of Fills or Backfills with Water

Settling of fills or backfills with water will not be permitted.

## 3.10.3 FILL MATERIAL

Fill material shall be obtained from the required excavation. Materials considered unsatisfactory for use as compacted fill include but are not limited to those materials containing roots and other organic matter, trash, debris, chunks or clumps of cemented material. Materials classified in ASTM D 2487 as MH, CH, Pt, OH, and OL are also considered unsatisfactory for use as compacted fill. Satisfactory fill material shall contain no stone whose greatest dimension is more than 3/4 the lift thickness. The Contractor shall expect to break-down, crush or otherwise process required excavation material for use as fill material due to the cementation of in-situ soils. The fill material shall have sufficient amount of fine material to fill the voids between coarser aggregate and shall conform to the following requirements:

Sieve Size (Millimeters)	Percent by Weight Passing
150	100
75	80 - 100

4.75

70 - 35

Material for compacted fill behind concrete structures, channel walls, and around box culverts shall contain less than 30 percent by weight passing the .075 mm sieve and shall contain no particle larger than 76 mm.

#### 3.10.4 Placement

Fill material shall not be placed against concrete which has not been in place at least 14 days or until the concrete has attained a strength of 17.2 megapascals when tested in accordance with the Section 03301 CAST-IN-PLACE STRUCTURAL CONCRETE. Fill shall not be placed over covered channels (roof decks) until the concrete has obtained 70% of the contract required design strength. Heavy equipment shall not be operated over pipes and buried structures until at least 600 mm of fill material have been placed and compacted over them. Material from the top of the pipe or buried structure to 600 mm above pipe or buried structure shall be compacted by mechanical tampers or other equipment approved by the Contracting Officer. Compacted fill shall be placed with suitable equipment in horizontal layers which before compaction, shall not exceed 300 mm in depth for rubber-tired or vibratory rollers, 200 mm in depth for tamping rollers, 100 mm in depth when mechanical tampers are used. The Contractor may vary the layer thickness within these limits for most efficient operations. Material containing stones shall be placed in a manner to prevent the stones from striking the concrete structures and to prevent the formation of voids.

#### 3.10.5 Moisture Content

Material shall have a uniform moisture content while being placed and compacted. Water shall be added at the source, if required, or by sprinkling each layer of material during placement. Uniform distribution of moisture shall be obtained by disking, harrowing, or otherwise manipulating the soil during and after time water is added. Material containing an excess of moisture shall be manipulated with suitable implements to facilitate maximum aeration and shall be permitted to dry to the proper consistency before being compacted. Fill shall have a maximum moisture content of not more than 2 percent above optimum and a minimum moisture content of not less than 2 percent below optimum.

#### 3.10.6 Compaction

No layer of fill shall be compacted before the practicable uniform moisture content has been obtained. Scarified areas shall be compacted as specified for the fill placed thereon. Rollers will not be permitted to operate within 300 mm of channel or structure walls or over buried structures until the compacted fill over the top of the structures has reached a depth of 600 mm. Compaction equipment shall be so operated that structures are not damaged nor overstressed during compaction operations. Mechanical tampers shall be used for compaction of fill material adjacent to structures where rolling equipment is impracticable for use in compaction.

#### 3.11 COMPACTED FILL, CHANNEL

### 3.11.1 Invert

#### 3.11.1.1 Preparation for Placing

The foundation for the compacted fill to be placed shall be cleared of all existing obstructions, vegetation and debris. Any trash or debris shall be removed in accordance with Section 02230 CLEAR SITE AND REMOVE OBSTRUCTIONS. Unsatisfactory or unstable (too wet) material and soils not meeting the requirements for fill material shall be removed where directed.

The existing surfaces for the compacted fill at the channel site shall be scarified to a depth of 150 mm and proofrolled by four passes of the compaction equipment. The subgrade for the channel shall be prepared in accordance with paragraph SUBGRADE PREPARATION.

#### 3.11.1.2 Compaction

Each layer of the material shall be compacted to not less than 95 percent of maximum density, per ASTM D 1557.

### 3.11.2 Behind Channel Walls

#### 3.11.2.1 Limitations on Equipment

The gross weight of any piece of equipment, or the combined weight of any combinations of equipment coupled together, used to place, moisten and/or compact fill behind channel walls and up to 600 mm above the top of covered sections shall not exceed 16,000 kilograms, including dynamic forces produced by vibratory equipment. Equipment used to compact the fill behind the channel walls shall be of such size as to be capable of operating in the area between the cut slope and the channel wall. Compaction equipment will not be required to operate at elevations lower than 600 mm above the top of wall footings. This equipment shall be of such size as to be capable of operating in the area between the cut slope and the channel wall at any point 600 mm above the top of the heel of wall footings.

#### 3.11.2.2 Construction Balance

Fills behind wall on one side of the channel shall not exceed by more than 1.5 meters the height of the fill behind the opposite channel wall at any time during construction (except restricted by design).

#### 3.11.2.3 Compaction

Each layer of fill behind channel walls, shall be compacted to not less than 90 percent of maximum density, per ASTM D 1557. The top 300 mm of the maintenance road adjacent to the channel wall shall be compacted to not less than 95 percent of maximum density per ASTM D 1557.

#### 3.11.2.4 Trimming

The top of fill adjacent to channel walls shall be trimmed to the lines indicated on the drawings with a tolerance of plus or minus 25 mm. Any material loosened by trimming shall be recompacted and the area moistened and compacted with one pass of a smooth-wheeled roller. Tolerances shall

apply after rolling. Fill slopes shall be trimmed to a uniform alignment at the top of the berm and reasonably uniform slope at or outside the lines shown on the drawings.

#### 3.11.2.5 Backfill Against Plywood at Ends of Pipe and Sewer Stubs

Plywood shall be braced or otherwise held flush against the end of the pipe during backfilling. The Contractor shall make sure the plywood is of sufficient size to adequately cover the pipe or sewer stub opening. The Contractor shall attach blocks or shims to roughly fit the inside diameter of the pipe to assure that the plywood is not displaced during backfilling.

#### 3.11.3 Compacted Fill Over Covered Channel

##### 3.11.3.1 General

No fill material shall be placed over the top of the covered channel until all voids at the sides of the covered channel have been filled as described below, and until all caved material has been compacted to the specified density to the top of the roof slab.

##### 3.11.3.2 Material

Materials for filling voids shall be clean sand, free of trash, organic materials, debris, and with 100 percent passing the 4.75 mm sieve and not more than 10 percent passing the 150 mm sieve.

##### 3.11.3.3 Placement

The first layer of fill over the concrete box section shall be 300 mm in thickness and shall be compacted with a rubber-tired or vibratory roller having a maximum weight of 9,000 kilograms. The remainder of the fill shall be deposited in 150 mm layers and compacted with rubber-tired or vibratory rollers, or other approved equipment with a maximum weight of 9,000 kilograms until the structure has a cover of at least 600 mm. The remainder of the compacted fill shall be placed as specified in paragraph COMPACTED FILL, CHANNEL of this section.

##### 3.11.3.4 Contractors Option

If the Contractor elects to leave the inside forms and shoring in place, permission will be granted to place fill material 48 hours after concrete has been placed.

##### 3.11.3.5 Compaction

Each layer of fill on top of the covered channel shall be compacted to not less than 95 percent of maximum density, per ASTM D 1557. Compacted Fill under streets and maintenance roads shall be compacted per paragraph COMPACTED FILL, ROADWAY.

#### 3.11.4 Compacted Fill, Roadway

##### 3.11.4 Compaction



Fill shall be compacted to not less than 95 percent of maximum density per ASTM D 1557 for the width of all traveled ways plus 1 meter on each side thereof.

#### 3.11.4.2 Trimming

All street and maintenance road shoulders and side slopes shall be trimmed to the lines indicated on the drawings with a tolerance of plus or minus 25 millimeters. Any material loosened by trimming shall be recompact and the area moistened and compacted with one pass of a smooth-wheeled roller. Tolerances shall apply after rolling. Fill slopes shall be trimmed to a reasonably uniform slope at or outside the lines shown on the drawings.

### 3.12 BACKFILL

#### 3.12.1 Structural Backfill

##### 3.12.1.1 Location

Backfill shall consist of all fill against and/or around structures, except compacted fill, channel.

##### 3.12.1.2 Material

Backfill material shall be obtained from the required excavation as approved by the Contracting Officer. In general, the best material available will be designated as backfill and fill about structures. Backfill may consist of sand, gravelly sand, and silty sands. Organic material, silt, clay, broken concrete or pavement, boulders and other unsatisfactory material shall not be used. Backfill for structures shall not contain any stones larger than 75 mm.

##### 3.12.1.3 Placing

Backfill material shall not be placed against concrete which has not been in place at least 14 days or until the concrete has attained a strength of 17.2 megapascals when tested in accordance with Section 03301 CAST-IN-PLACE STRUCTURAL CONCRETE.

##### 3.12.1.4 Compaction

Compaction shall be not less than 95 percent of maximum density, per ASTM D 1557 unless noted or shown otherwise.

### 3.13 SUBGRADE PREPARATION

#### 3.13.1 Subgrade for Channel

Subgrade preparation for channel shall include subgrade preparation for areas to receive concrete, aggregate base course and/or bituminous paving for streets, access roads, maintenance roads, turnarounds, and invert access ramps. All trash and debris shall be removed in accordance with Section 02230 CLEAR SITE AND REMOVE OBSTRUCTIONS. After the channel has

been excavated to rough grade, the entire channel invert, invert access ramp, and other area indicated above shall be scarified to a depth of 0.15 meters, moisture conditioned and proofrolled by 4 passes of the compaction equipment and trimmed to a uniform grade and smoothed with a steel-wheeled roller to make the subgrade ready to receive concrete. If the subgrade is disturbed by the Contractor's operations or is overexcavated, or is soft or yielding, the subgrade shall be restored to grade and compacted to a density of 95 percent of maximum density, per ASTM D 1557. The finished surface of the subgrade shall not be more than 13 mm above the indicated grade at any point when tested with a 3 meters straightedge.

### 3.14 SOIL STABILIZER

All exposed excavation and fill surfaces and disturbed surface areas in the project area not covered by concrete or asphalt or landscaping work including revegetation shall be treated with a soil stabilizer for soil stabilization and dust control with the concentrations stated in paragraph SOIL STABILIZER PRODUCT after construction is completed. The soil stabilizer shall be watered in per the manufacturer's recommendations.

Processed gypsum that has become partially air set, lumpy, or caked shall not be used. The plaster/cellulose fiber mulch shall be applied at a rate of 6.75 tonnes of plaster mixed with 2.242 tonnes of fiber per hectare.

The plaster/cellulose fiber mulch stabilizer shall formulate a protective crust-like barrier within 4 to 8 hours after application. Application of the plaster/cellulose fiber mulch stabilizer shall not be permitted when weather conditions are unsuitable for concrete placement in accordance with Section 03301 CAST-IN-PLACE STRUCTURAL CONCRETE.

-- End of Section --

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## DIVISION 02 - SITE WORK

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## SECTION 02316

## EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 1556	(2000) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(2000) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu.m.))
ASTM D 2487	(2000) Classification of Soils for Engineering Purposes (Unified Soil Classification System)

## 1.2 MEASUREMENT AND PAYMENT

No separate payment will be made for trench excavation and trench backfill for utilities. All costs in connection therewith shall be included in the contract prices for items to which the work applies.

## 1.3 DEGREE OF COMPACTION

Degree of compaction shall be expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557.

## 1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Field Density Tests; G, RE.

Testing of Backfill Materials; G, RE.

Copies of all laboratory and field test reports within 24 hours of the completion of the test.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Satisfactory Materials

Satisfactory materials shall comprise any materials classified by ASTM D 2487 as GW, GP, GM, GC, SW, SP, SM, SC and CL.

2.1.2 Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Unsatisfactory materials also include man-made fills, trash, refuse, or backfills from previous construction. Unsatisfactory material also includes material classified by ASTM D 2487 as CH, PT, OH, MH, and OL and satisfactory material which contains root and other organic matter. The Contracting Officer shall be notified of any contaminated materials.

2.1.3 Cohesionless and Cohesive Materials

Cohesionless materials shall include materials classified in ASTM D 2487 as GW, GP, SW, and SP. Cohesive materials shall include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM shall be identified as cohesionless only when the fines are nonplastic.

2.1.4 Unyielding Material

Unyielding material shall consist of rock and gravelly soils with stones greater than 75 millimeters in any dimension or as defined by the pipe manufacturer, whichever is smaller.

2.1.5 Unstable Material

Unstable material shall consist of materials too wet to properly support the utility pipe, conduit, or appurtenant structure.

2.1.6 Select Granular Material

Select granular material shall consist of well-graded sand, gravel, crushed gravel, crushed stone or crushed slag composed of hard, tough and durable particles, and shall contain not more than 10 percent by weight of material passing a 0.075 mm mesh sieve and no less than 95 percent by weight passing the 25 mm sieve. The maximum allowable aggregate size shall be 13 millimeters, or the maximum size recommended by the pipe manufacturer, whichever is smaller.

2.1.7 Initial Backfill Material

Initial backfill shall consist of select granular material or satisfactory materials free from rocks 25 millimeters or larger in any dimension or free from rocks of such size as recommended by the pipe manufacturer, whichever is smaller. When the pipe is coated or wrapped for corrosion protection, the initial backfill material shall be free of stones larger than 13 millimeters in any dimension or as recommended by the pipe manufacturer, whichever is smaller.

## 2.2 PLASTIC MARKING TAPE

Plastic marking tape shall be acid and alkali-resistant polyethylene film, 150 mm wide with minimum thickness of 0.100 mm. Tape shall have a minimum strength of 12.1 MPa lengthwise and 10.3 MPa crosswise. The tape shall be manufactured with integral wires, foil backing or other means to enable detection by a metal detector when the tape is buried up to 1 meter deep. The tape shall be of a type specifically manufactured for marking and locating underground utilities. The metallic core of the tape shall be encased in a protective jacket or provided with other means to protect it from corrosion. Tape color shall be as specified in TABLE 1 and shall bear a continuous printed inscription describing the specific utility.

TABLE 1. Tape Color

Red:	Electric
Yellow:	Gas, Oil, Dangerous Materials
Orange:	Telephone, Telegraph, Television, Police, and Fire Communications
Blue:	Water Systems
Green:	Sewer Systems

## PART 3 EXECUTION

### 3.1 EXCAVATION

Excavation shall be performed to the lines and grades indicated. Excavation shall consist of the removal of every type of material encountered. The material to be removed may include but is not limited to hardpan, silt, sand, gravel, cobbles and boulders, cemented silt/sand/gravel/cobbles/boulders (cemented materials) with various degrees of cementation, caliche, rock, asphalt, vegetation, trash, and other debris. Excavation may require ripping or other rock-excavation techniques. Use of the heavy tractors equipped with a ripper tooth, hoe-rams, and hydraulic or pneumatic rock breaker could be necessary to excavate highly cemented soils. Rock or cemented material from required excavation to be used in compacted fills and backfills shall be crushed or otherwise reduced in size to meet gradation requirements prior to placement or stockpiling. During excavation, material satisfactory for backfilling shall be stockpiled in an orderly manner at a distance from the banks of the trench equal to 1/2 the depth of the excavation, but in no instance closer than 600 mm. Excavated material not satisfactory for backfill shall become property of the contractor and removed from the project site. Excess (satisfactory) excavated materials shall be hauled, placed and compacted in the disposal site per lines and grades shown on the drawing sheet 30. Excess excavated materials including rocks and cemented soils shall be processed/crushed or

otherwise reduced in sizes not exceeding  $\frac{3}{4}$  of the lift thickness, prior to hauling and placing in disposal site. Grading shall be done as may be necessary to prevent surface water from flowing into the excavation, and any water accumulating shall be removed to maintain the stability of the bottom and sides of the excavation. Unauthorized overexcavation shall be backfilled in accordance with paragraph BACKFILLING AND COMPACTION at no additional cost to the Government.

#### 3.1.1 Trench Excavation Requirements

The trench shall be excavated as recommended by the manufacturer of the pipe to be installed. Trench walls below the top of the pipe shall be sloped, or made vertical, and of such width as recommended in the manufacturer's installation manual. Where no manufacturer's installation manual is available, trench walls shall be made vertical. Trench walls more than 1.5 meters high shall be shored, cut back to a stable slope, or provided with equivalent means of protection for employees who may be exposed to moving ground or cave in. Vertical trench walls more than 1.5 meters high shall be shored. Trench walls which are cut back shall be excavated to at least the angle of repose of the soil. Special attention shall be given to slopes which may be adversely affected by weather or moisture content. The trench width below the top of pipe shall not exceed 600 mm plus pipe outside diameter (O.D.) for pipes of less than 600 mm inside diameter and shall not exceed 900 mm plus pipe outside diameter for sizes larger than 600 mm inside diameter. Where recommended trench widths are exceeded, redesign, stronger pipe, or special installation procedures shall be utilized by the Contractor. The cost of redesign, stronger pipe, or special installation procedures shall be borne by the Contractor without any additional cost to the Government.

##### 3.1.1.1 Bottom Preparation

The bottoms of trenches shall be accurately graded to provide uniform bearing and support. The trench subgrade shall not vary more than 13 millimeters from the indicated grade. Stones of 75 millimeters or greater in any dimension, or as recommended by the pipe manufacturer, whichever is smaller, shall be removed to avoid point bearing.

##### 3.1.1.2 Removal of Unyielding Material

Where overdepth is not indicated and unyielding material is encountered in the bottom of the trench, such material shall be removed 150 millimeters below the required grade and replaced with suitable materials as provided in paragraph BACKFILLING AND COMPACTION.

##### 3.1.1.3 Removal of Unstable Material

Where unstable material is encountered in the bottom of the trench, such material shall be removed to the depth directed and replaced to the proper grade with select granular material as provided in paragraph BACKFILLING AND COMPACTION. When removal of unstable material is required due to the Contractor's fault or neglect in performing the work, the resulting material shall be excavated and replaced by the Contractor without additional cost to the Government.



#### 3.1.1.4 Excavation for Appurtenances

Excavation for manholes, catch-basins, inlets, or similar structures shall be of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown. Rock shall be cleaned of loose debris and cut to a firm surface either level, stepped, or serrated, as shown or as directed. Loose disintegrated rock and thin strata shall be removed. Removal of unstable material shall be as specified above. When concrete or masonry is to be placed in an excavated area, special care shall be taken not to disturb the bottom of the excavation. Excavation to the final grade level shall not be made until just before the concrete or masonry is to be placed.

#### 3.1.1.5 Jacking, Boring, and Tunneling

Unless otherwise indicated, excavation shall be by open cut except that sections of a trench may be jacked, bored, or tunneled if, in the opinion of the Contracting Officer, the pipe, cable, or duct can be safely and properly installed and backfill can be properly compacted in such sections.

#### 3.1.2 Stockpiles

Stockpiles of satisfactory shall be placed and graded as specified. Stockpiles shall be kept in a neat and well drained condition, giving due consideration to drainage at all times. The ground surface at stockpile locations shall be cleared, grubbed, and sealed by rubber-tired equipment, excavated satisfactory and unsatisfactory materials shall be separately stockpiled. Stockpiles of satisfactory materials shall be protected from contamination which may destroy the quality and fitness of the stockpiled material. If the Contractor fails to protect the stockpiles, and any material becomes unsatisfactory, such material shall be removed and replaced with satisfactory material from approved sources at no additional cost to the Government. Locations of stockpiles of satisfactory materials shall be subject to prior approval of the Contracting Officer.

### 3.2 BACKFILLING AND COMPACTION

Backfill material shall consist of satisfactory material, select granular material, or initial backfill material as required. Backfill shall be placed in layers not exceeding 150 mm loose thickness for compaction by hand operated machine compactors, and 200 mm loose thickness for other than hand operated machines, unless otherwise specified. Each layer shall be compacted to at least 90 percent maximum density in accordance with ASTM D 1557.

#### 3.2.1 Trench Backfill

Trenches shall be backfilled to the grade shown. The trench shall not be backfilled until all specified tests are performed.

##### 3.2.1.1 Replacement of Unyielding Material

Unyielding material removed from the bottom of the trench shall be replaced

with select granular material or initial backfill material.

#### 3.2.1.2 Replacement of Unstable Material

Unstable material removed from the bottom of the trench or excavation shall be replaced with select granular material placed in layers not exceeding 150 mm loose thickness.

#### 3.2.1.3 Bedding and Initial Backfill

Bedding material type and thickness shall be in accordance with pipe manufacturer recommendations. Initial backfill material shall consist of select granular material and shall be placed and compacted with approved tampers to a height of at least one foot above the utility pipe or conduit.

The backfill shall be brought up evenly on both sides of the pipe for the full length of the pipe. Care shall be taken to ensure thorough compaction of the fill under the haunches of the pipe.

#### 3.2.1.4 Final Backfill

The remainder of the trench shall be filled with satisfactory material and compacted to at least 90 percent maximum density in accordance with ASTM D 1557 except, top 1 meter under the roadways and maintenance roads shall be compacted to not less than 95% of maximum density per ASTM D 1557.

#### 3.2.2 Backfill for Appurtenances

After the manhole, catch basin, inlet, or similar structure has been constructed and the concrete has been allowed to cure for 14 days, backfill shall be placed in such a manner that the structure will not be damaged by the shock of falling earth. The backfill material shall be deposited and compacted as specified for final backfill, and shall be brought up evenly on all sides of the structure to prevent eccentric loading and excessive stress.

### 3.3 SPECIAL REQUIREMENTS

Special requirements for both excavation and backfill relating to the specific utilities are as follows:

#### 3.3.1 Gas Distribution

Trenches shall be excavated to a depth that will provide not less than 450 mm of cover in rock excavation and not less than 600 mm of cover in other excavation.

#### 3.3.2 Water Lines

Trenches shall be of a depth to provide a minimum cover of 750 millimeters from the existing ground surface, or from the indicated finished grade, whichever is lower, to the top of the pipe.

#### 3.3.3 Plastic Marking Tape

Warning tapes shall be installed directly above the pipe, at a depth of 450 millimeters below finished grade unless otherwise shown.

### 3.4 TESTING

Testing shall be the responsibility of the Contractor and shall be performed at no additional cost to the Government.

#### 3.4.1 Testing Facilities

Tests shall be performed by an approved commercial testing laboratory or may be tested by facilities furnished by the Contractor. No work requiring testing will be permitted until the facilities have been inspected and approved by the Contracting Officer. The first inspection shall be at the expense of the Government. Cost incurred for any subsequent inspection required because of failure of the first inspection will be charged to the Contractor.

#### 3.4.2 Testing of Backfill Materials

Classification of backfill materials shall be determined in accordance with ASTM D 2487 and the moisture-density relations of soils shall be determined in accordance with ASTM D 1557. A minimum of one soil classification and one moisture-density relation test shall be performed on each different type of material used for bedding and backfill.

#### 3.4.3 Field Density Tests

Tests shall be performed in sufficient numbers to ensure that the specified density is being obtained. A minimum of one field density test per lift of backfill for every 200 cubic meters of installation shall be performed. One moisture density relationship shall be determined for every 500 cubic meters of material used. Field in-place density shall be determined in accordance with ASTM D 1556. Trenches improperly compacted shall be reopened to the depth directed, then refilled and compacted to the density specified at no additional cost to the Government.

#### 3.4.4 Displacement of Sewers

After other required tests have been performed and the trench backfill compacted to 600 millimeters above the top of the pipe, the pipe shall be inspected to determine whether significant displacement has occurred. This inspection shall be conducted in the presence of the Contracting Officer. Pipe sizes larger than 900 mm shall be entered and examined, while smaller diameter pipe shall be inspected by shining a light or laser between manholes or manhole locations, or by the use of television cameras passed through the pipe. If, in the judgement of the Contracting Officer, the interior of the pipe shows poor alignment or any other defects that would cause improper functioning of the system, the defects shall be remedied as directed at no additional cost to the Government.

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## SECTION 02500

## STATION MARKINGS

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

## U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS TT-P-1952 (Rev D; Canc. Notice 1) Paint, Traffic and  
Airfield Marking, Waterborne (Metric)

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Composition Requirements; G, RE.

Manufacturer's current printed product description and Material Safety Data Sheets (MSDS) for each type paint/color proposed for use.

## PART 2 PRODUCTS

## 2.1 MATERIALS

The paint shall be homogeneous, easily stirred to smooth consistency, and shall show no hard settlement or other objectionable characteristics during a storage period of 6 months. Paints shall conform to FS TT-P-1952, color non-fading black. Station marking paints shall comply with applicable state and local laws enacted to ensure compliance with Federal Clean Air Standards. Paint materials shall conform to the restrictions of the local Air Pollution Control District. The Contractor shall submit the Composition Requirements of the paint intended for use on the project to the Government for approval prior to use of the paint.

## PART 3 EXECUTION

## 3.1 SURFACE PREPARATION

All markings shall be painted on concrete walls (channel walls, headwalls, abutments, etc.). Surfaces to be marked shall be thoroughly cleaned before application of the marking material.

### 3.2 APPLICATION

Paint shall be applied by brush, spray, roller or any combination of these methods to clean, dry surfaces, and only when air and pavement temperatures are above 5 degrees C and less than 35 degrees C. Paint temperature shall be maintained within these same limits. New concrete shall be allowed to cure for a period of not less than 30 days before applications of paint. The Contractor shall provide guide lines and templates or stencils as necessary to control paint application. Special precautions shall be taken in marking numbers, letters, and symbols. Edges of markings shall be sharply outlined.

#### 3.2.1 Marking

The intersection of the channel center line and levee control line with the center line of new, relocated, and existing facilities such as bridges and street intersections, pole lines, underground utility crossings, side drains, upstream and downstream limits of permanent work, and other required information shall be marked by painting station numbers and additional identifying data as listed in the tabulation of location of text of markings. All markings on concrete shall be in uniform capital block letters and numbers, 6 inches high, 3 inches wide, and 3/4-inch width of line. Markings on concrete walls shall be horizontal with the bottom of the marking not lower than 2 feet below the top of the wall.

### 3.3 TABULATION OF LOCATION AND TEXT OF MARKINGS

#### 3.3.1 Abbreviations

The following abbreviations shall be used where applicable.

R= Right Channel Wall (looking downstream)

#### 3.3.2 Tabulation

Location of Marking Wall	Station*	Text of Marking	Location of Marking Wall	Station*	Text of Marking
R	37+21.781	9400	R	53+98.184	14900
R	37+52.261	9500	R	54+28.664	15000
R	37+82.741	9600	R	54+59.144	15100
R	38+13.221	9700	R	54+89.625	15200
R	38+43.701	9800	R	55+20.105	15300
R	38+74.181	9900	R	55+50.585	15400
R	39+04.661	10000	R	55+81.065	15500
R	39+35.141	10100	R	56+11.545	15600
R	39+65.621	10200	R	56+42.025	15700
R	39+96.102	10300	R	56+72.505	15800
R	40+26.582	10400	R	57+02.985	15900

R	40+57.062	10500	R	57+33.465	16000
R	40+87.542	10600	R	57+63.945	16100
R	41+18.022	10700	R	57+94.425	16200
R	41+48.502	10800	R	58+24.905	16300
R	41+78.982	10900	R	58+55.385	16400
R	42+09.462	11000	R	58+85.865	16500
R	42+39.942	11100	R	59+16.345	16600
R	42+70.422	11200	R	59+46.825	16700
R	43+00.902	11300	R	59+77.306	16800
R	43+31.382	11400	R	60+07.786	16900
R	43+61.862	11500	R	60+38.266	17000
R	43+92.342	11600	R	60+68.746	17100
R	44+22.822	11700	R	60+99.226	17200
R	44+53.302	11800	R	61+29.706	17300
R	44+83.783	11900	R	61+60.186	17400
R	45+14.263	12000	R	61+90.666	17500
R	45+44.743	12100	R	62+21.146	17600
R	45+75.223	12200	R	62+51.626	17700
R	46+05.703	12300	R	62+82.106	17800
R	46+36.183	12400	R	63+12.586	17900
R	46+66.663	12500	R	63+43.066	18000
R	46+97.143	12600	R	63+73.546	18100
R	47+27.623	12700	R	64+04.026	18200
R	47+58.103	12800	R	64+34.506	18300
R	47+88.583	12900	R	64+64.986	18400
R	48+19.063	13000	R	64+95.467	18500
R	48+49.543	13100	R	65+25.947	18600
R	48+80.023	13200	R	65+56.427	18700
R	49+10.503	13300	R	65+86.907	18800
R	49+40.983	13400	R	66+17.387	18900
R	49+71.464	13500	R	66+47.867	19000
R	50+01.944	13600	R	66+78.347	19100
R	50+32.424	13700	R	67+08.827	19200
R	50+62.904	13800	R	67+39.307	19300
R	50+93.384	13900	R	67+69.787	19400
R	51+23.864	14000	R	68+00.267	19500
R	51+54.344	14100	R	68+30.747	19600
R	51+84.824	14200	R	68+61.227	19700
R	52+15.304	14300	R	68+91.707	19800
R	52+45.784	14400	R	69+22.187	19900
R	52+76.264	14500	R	69+52.667	20000
R	53+06.744	14600	R	69+83.148	20100
R	53+37.224	14700	R	70+00.000	20155.29
R	53+67.704	14800			

\* = The actual location of the channel station shall be accurate to the nearest half meter.

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## SECTION 02510A

## WATER DISTRIBUTION SYSTEM

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36/A 36M	(2000) Carbon Structural Steel
ASTM A 53	(1999b) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM B 88M	(1996) Seamless Copper Water Tube (Metric)
ASTM D 1599	(1999) Resistance to Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings
ASTM D 1784	(1999a) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 1785	(1999) Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2241	(1996b) Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2464	(1999) Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2466	(1999) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2467	(1999) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2564	(1996a) Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2657	(1997) Heat Fusion Joining Polyolefin Pipe and Fittings

ASTM D 2774	(1994) Underground Installation of Thermoplastic Pressure Piping
ASTM D 2855	(1996) Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D 2996	(1995) Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D 2997	(1999) Centrifugally Cast "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D 3139	(1998) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D 3839	(1994a) Underground Installation of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe
ASTM D 4161	(1996) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe Joints Using Flexible Elastomeric Seals
ASTM F 477	(1999) Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 1483	(1998) Oriented Poly(Vinyl Chloride), PVC0, Pressure Pipe

## ASME INTERNATIONAL (ASME)

ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch)
ASME B16.1	(1998) Cast Iron Pipe Flanges and Flanged Fittings
ASME B16.3	(1992) Malleable Iron Threaded Fittings
ASME B16.26	(1988) Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B36.10M	(1996) Welded and Seamless Wrought Steel Pipe

## AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA B300	(1992) Hypochlorites
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AWWA B301	(1992) Liquid Chlorine
AWWA C104	(1995) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C105	(1999) Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C110	(1998) Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (75 mm through 1200 mm), for Water and Other Liquids
AWWA C111	(2000) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115	(1999) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C151	(1996) Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids
AWWA C153	(1994; Errata Nov 1996) Ductile-Iron Compact Fittings, 3 In. Through 24 In. (76 mm through 610 mm) and 54 In. through 64 In. (1,400 mm through 1,600 mm) for Water Service
AWWA C200	(1997) Steel Water Pipe - 6 In. (150 mm) and Larger
AWWA C203	(1997) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C205	(1995) Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 In. (100 mm) and Larger - Shop Applied
AWWA C207	(1994) Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In. (100 mm through 3,600 mm)
AWWA C208	(1996) Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C300	(1997) Reinforced Concrete Pressure Pipe, Steel-Cylinder Type, for Water and Other Liquids
AWWA C301	(1992) Prestressed Concrete Pressure Pipe, Steel-Cylinder Type, for Water and Other Liquids

AWWA C303	(1995) Concrete Pressure Pipe, Bar-Wrapped, Steel Cylinder Type
AWWA C500	(1993; C500a) Metal-Sealed Gate Valves for Water Supply Service
AWWA C504	(1994) Rubber-Seated Butterfly Valves
AWWA C509	(1994; Addendum 1995) Resilient-Seated Gate Valves for Water Supply Service
AWWA C600	(1993) Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C606	(1997) Grooved and Shouldered Joints
AWWA C651	(1992) Disinfecting Water Mains
AWWA C700	(1995) Cold-Water Meters - Displacement Type, Bronze Main Case
AWWA C701	(1988) Cold-Water Meters - Turbine Type, for Customer Service
AWWA C702	(1992) Cold-Water Meters - Compound Type
AWWA C703	(1996) Cold-Water Meters - Fire Service Type
AWWA C704	(1992) Propeller-Type Meters Waterworks Applications
AWWA C706	(1996) Direct-Reading, Remote-Registration Systems for Cold-Water Meters
AWWA C707	(1982; R 1992) Encoder-Type Remote-Registration Systems for Cold-Water Meters
AWWA C800	(1989) Underground Service Line Valves and Fittings
AWWA C900	(1997; C900a) Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In., for Water Distribution
AWWA C901	(1996) Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. Through 3 In., for Water Service
AWWA C905	(1997) Polyvinyl Chloride (PVC) Water Transmission Pipe, Nominal Diameters 14 In. Through 36 In.

AWWA C909 (1998) Molecularly Oriented Polyvinyl Chloride (PVC) Pressure Pipe, 4 IN through 12 IN (100 mm through 300 mm), for Water Distribution

AWWA C950 (1995) Fiberglass Pressure Pipe

AWWA M23 (1980) Manual: PVC Pipe - Design and Installation

ASBESTOS CEMENT PIPE PRODUCERS ASSOCIATION (ACPPA)

ACPPA Work Practices (1988) Recommended Work Practices for A/C Pipe

DUCTILE IRON PIPE RESEARCH ASSOCIATION (DIPRA)

DIPRA-Restraint Design (1997) Thrust Restraint Design for Ductile Iron Pipe

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-80 (1997) Bronze Gate, Globe, Angle and Check Valves

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 24 (1995) Installation of Private Fire Service Mains and Their Appurtenances

NFPA 49 (1994) Hazardous Chemicals Data

NFPA 325-1 (1994) Fire Hazard Properties of Flammable Liquids, Gases, and Volatile Solids

NFPA 704 (1996) Identification of the Fire Hazards of Materials for Emergency Response

NSF INTERNATIONAL (NSF)

NSF 14 (1998) Plastics Piping Components and Related Materials

NSF 61 (1999) Drinking Water System Components - Health Effects (Sections 1-9)

## 1.2 PIPING

This section covers water distribution lines. All work shall conform to the Las Vegas Valley Water District Standard Plates, Drawings, Specifications and the "Uniform Design and Construction Standards for Water Distribution Systems," UDACS, latest edition. The Contractor shall have a copy of the manufacturer's recommendations for each material or procedure



to be utilized available at the construction site at all times.

#### 1.2.1 Distribution Lines 75 mm (3 Inches) or Larger

Piping for water distribution lines 80 mm or larger shall be ductile iron, polyvinyl chloride (PVC) through 900 mm nominal diameter plastic, Oriented PVC plastic filament-wound or centrifugally cast reinforced thermosetting resin, reinforced plastic mortar pressure pipe, or reinforced concrete, unless otherwise shown or specified.

#### 1.2.2 Supply Lines 80 mm (3 Inches) or Larger

Piping for water supply lines 80 mm or larger shall be ductile iron, polyvinyl chloride (PVC) plastic, through 900 mm nominal diameter, Oriented PVC plastic filament-wound reinforced or centrifugally cast reinforced thermosetting resin, reinforced plastic mortar pressure pipe, steel, or reinforced concrete, unless otherwise shown or specified.

#### 1.2.3 Potable Water Lines

Piping and components of potable water systems which come in contact with the potable water shall conform to NSF 61.

#### 1.2.4 Plastic Piping System

Plastic piping system components (PVC, polyethylene, thermosetting resin and reinforced plastic mortar pressure) intended for transportation of potable water shall comply with NSF 14 and be legibly marked with their symbol.

#### 1.2.5 Excavation, Trenching, and Backfilling

Excavation, trenching, and backfilling shall be in accordance with the applicable provisions of Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS, except as modified herein.

### 1.3 UNIT PRICES

Measurement and payment will be based on completed work performed in accordance with the drawings, specifications, and the contract payment schedules. Payment will not be made under this section for excavation, trenching, or backfilling. Payment for such work will be made under Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.

#### 1.3.1 Measurement

The length of water lines to be paid for will be determined by measuring along the centerlines of the various sizes of pipe furnished and installed.

Pipe will be measured from center of fitting to center of fitting, from center of water distribution line to end of service connection, and from center of water distribution line to center of hydrant. No deduction will be made for the space occupied by valves or fittings.

#### 1.3.2 Payment

Payment will be made for water lines at the contract unit price per linear meter for the various types and sizes of water lines, and will be full compensation for all pipes, joints, specials, and fittings, complete in place. Payment for fire hydrants, gate valves, valve boxes, and standard valve manholes will be made at the respective contract unit price each for such items complete in place. Payment will include the furnishing of all testing, plant, labor, and material and incidentals necessary to complete the work, as specified and as shown.

#### 1.4 MANUFACTURER'S REPRESENTATIVE

The Contractor shall have a manufacturer's field representative present at the jobsite during the installation and testing of PE, RTRP, and/or RPMP pipe to provide technical assistance and to verify that the materials are being installed in accordance with the manufacturer's prescribed procedures. When the representative feels that the Contractor is installing and testing the PE, RTRP, and/or RPMP pipe in a satisfactory manner, certification shall be written to note which individuals employed by the Contractor are capable of properly installing the pipe. The field representative shall advise the Contractor of unsatisfactory conditions immediately when they occur. Such conditions include improper diameter of pipe ends, damaged interior liner, poorly prepared joints, improper curing of joints, moving pipe before joints are cured, bending pipe to follow abrupt changes in trench contours, leaving pipe ends open in trench overnight, not properly drying joints after rain storms, exceeding effective adhesive life, sharp objects in trench bed, backfill that could damage pipe, improper procedure for concrete encasement of pipe, omission of thrust blocks at changes in direction or any other condition which could have an adverse effect on the satisfactory completion and operation of the piping system.

#### 1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Installation; G, RE.

The manufacturer's recommendations for each material or procedure to be utilized.

Waste Water Disposal Method; G, RE.

The method proposed for disposal of waste water from hydrostatic tests and disinfection, prior to performing hydrostatic tests.

Satisfactory Installation; G, RE.

A statement signed by the principal officer of the contracting firm stating that the installation is satisfactory and in accordance with the contract drawings and specifications, and the manufacturer's prescribed procedures and techniques, upon completion of the project and before final acceptance.

#### SD-06 Test Reports

Bacteriological Disinfection; G, RE.

Test results from commercial laboratory verifying disinfection.

#### SD-07 Certificates

Manufacturer's Representative; G, RE.

The name and qualifications of the manufacturer's representative and written certification from the manufacturer that the representative is technically qualified in all phases of PE, RTRP, and/or RPMP pipe laying and jointing and experienced to supervise the work and train the Contractor's field installers, prior to commencing installation.

Installation; G, RE.

A statement signed by the manufacturer's field representative certifying that the Contractor's personnel are capable of properly installing the pipe on the project.

Meters; G, RE.

Manufacturer's certificate stating that each meter furnished has been tested for accuracy of registration and compliance with the accuracy and capacity requirements of the appropriate AWWA standard.

### 1.6 HANDLING

Pipe and accessories shall be handled to ensure delivery to the trench in sound, undamaged condition, including no injury to the pipe coating or lining. If the coating or lining of any pipe or fitting is damaged, the repair shall be made by the Contractor in a satisfactory manner, at no additional cost to the Government. No other pipe or material shall be placed inside a pipe or fitting after the coating has been applied. Pipe shall be carried into position and not dragged. Use of pinch bars and tongs for aligning or turning pipe will be permitted only on the bare ends of the pipe. The interior of pipe and accessories shall be thoroughly cleaned of foreign matter before being lowered into the trench and shall be kept clean during laying operations by plugging or other approved method. Before installation, the pipe shall be inspected for defects. Material found to be defective before or after laying shall be replaced with sound material without additional expense to the Government. Rubber gaskets that are not to be installed immediately shall be stored in a cool and dark place.

#### 1.6.1 Coated and Wrapped Steel Pipe

Coated and wrapped steel pipe shall be handled in conformance with AWWA C203.

#### 1.6.2 Polyethylene (PE) Pipe Fittings and Accessories

PE pipe, fittings, and accessories shall be handled in conformance with AWWA C901.

#### 1.6.3 Miscellaneous Plastic Pipe and Fittings

Polyvinyl Chloride (PVC), Reinforced Thermosetting Resin Pipe (RTRP), and Reinforced Plastic Mortar Pressure (RPMP) pipe and fittings shall be handled and stored in accordance with the manufacturer's recommendations. Storage facilities shall be classified and marked in accordance with NFPA 704, with classification as indicated in NFPA 49 and NFPA 325-1.

### PART 2 PRODUCTS

#### 2.1 PIPE

Pipe shall conform to the respective specifications and other requirements specified below.

##### 2.1.1 Reinforced and Prestressed Concrete Pipe

Steel cylinder reinforced concrete pipe shall conform to AWWA C300, AWWA C301, or AWWA C303 and shall be designed to withstand a working pressure of not less than 1.03 MPa (150 psi) unless otherwise shown or specified.

##### 2.1.2 Plastic Pipe

###### 2.1.2.1 PE Plastic Pipe

Pipe, tubing, and heat-fusion fittings shall conform to AWWA C901.

###### 2.1.2.2 PVC Plastic Pipe

Pipe, couplings and fittings shall be manufactured of material conforming to ASTM D 1784, Class 12454B.

###### a. Pipe Less Than 100 mm (4 inch) Diameter:

(1) Screw-Joint: Pipe shall conform to dimensional requirements of ASTM D 1785 Schedule 80, with joints meeting requirements of 1.03 MPa (150 psi) working pressure, 1.38 MPa (200 psi) hydrostatic test pressure, unless otherwise shown or specified. Pipe couplings when used, shall be tested as required by ASTM D 2464.

(2) Elastomeric-Gasket Joint: Pipe shall conform to dimensional requirements of ASTM D 1785 Schedule 40, with joints meeting the requirements of 1.03 MPa (150 psi) working pressure, 1.38 MPa (200 psi) hydrostatic test pressure, unless otherwise shown or specified, or it may be pipe conforming to requirements of ASTM D 2241, elastomeric joint, with the following applications:

SDR	Maximum Working Pressure MPa	Minimum Hydrostatic Pressure MPa
26	0.689	0.917
21	0.827	1.103
17	1.034	1.379
13.5	1.379	1.834

(3) Solvent Cement Joint: Pipe shall conform to dimensional requirements of ASTM D 1785 or ASTM D 2241 with joints meeting the requirements of 1.03 MPa (150 psi) working pressure and 1.38 MPa (200 psi) hydrostatic test pressure.

- b. Pipe 100 through 300 mm Diameter: Pipe, couplings and fittings shall conform to AWWA C900, Class 150, CIOD pipe dimensions, elastomeric-gasket joint, unless otherwise shown or specified.
- c. Pipe 350 through 900 mm Diameter: Pipe shall conform to AWWA C905 unless otherwise shown or specified.

#### 2.1.2.3 Oriented Polyvinyl Chloride (PVC) Plastic Pipe

Pipe, couplings, and fittings shall be manufactured of material conforming to ASTM D 1784, Class 12454-B. Pipe shall conform to AWWA C909, Class 150, and to ASTM F 1483 and shall have an outside diameter equal to cast iron outside diameter.

#### 2.1.3 Reinforced Plastic Mortar Pressure (RPMP) Pipe

RPMP shall be produced by centrifugal casting and shall have an OD 304 to 1219 mm equal to ductile-iron, with a 1034 kPa pressure rating and with a minimum pipe stiffness of 248 kPa. RPMP shall be in accordance with AWWA C950.

#### 2.1.4 Reinforced Thermosetting Resin Pipe (RTRP)

Pipe shall have a quick-burst strength greater than or equal to four times the normal working pressure of the pipe. The quick-burst strength test shall conform to the requirements of ASTM D 1599.

##### 2.1.4.1 RTRP-I

RTRP-I shall conform to ASTM D 2996, except pipe shall have an outside diameter equal to cast iron outside diameter or standard weight steel pipe.

The pipe shall be suitable for a normal working pressure of 1.03 MPa (150 psi) at 23 degrees C. The inner surface of the pipe shall have a smooth uniform continuous resin-rich surface liner conforming to ASTM D 2996.

##### 2.1.4.2 RTRP-II

RTRP-II shall conform to ASTM D 2997. Pipe shall have an outside diameter

equal to standard weight steel pipe.

#### 2.1.5 Ductile-Iron Pipe

Ductile-iron pipe shall conform to AWWA C151, working pressure not less than 1.03 MPa (150 psi), unless otherwise shown or specified. Pipe shall be cement-mortar lined in accordance with AWWA C104. Linings shall be standard. When installed underground, pipe shall be encased with 0.15 mm thick polyethylene in accordance with AWWA C105. Flanged ductile iron pipe with threaded flanges shall be in accordance with AWWA C115.

#### 2.1.6 Steel Pipe

##### 2.1.6.1 Pipe 80 mm (3 Inches) and Larger, Not Galvanized

Steel pipe, not galvanized, shall conform to AWWA C200 with dimensional requirements as given in ASME B36.10M for pipe 150 mm (6 inches) in diameter and larger, and ASTM A 53 for smaller sizes. Pipe shall be welded or seamless with plain or shouldered and grooved ends in accordance with AWWA C606 for use with mechanical couplings or bell-and-spigot ends with rubber gaskets. Bell-and-spigot ends for sizes less than 150 mm (6 inches) diameter shall be as required by AWWA C200. The minimum wall thickness of the various sizes of pipe shall be as follows:

Pipe Sizes	Thickness
50 mm to 76 mm	6 mm
80 mm to 155 mm	13 mm
160 mm to 914 mm	25 mm

##### 2.1.6.2 Galvanized Steel Pipe

Galvanized steel pipe shall conform to ASTM A 53, standard weight.

##### 2.1.6.3 Protective Materials for Steel Pipe

Protective materials for steel pipe, except as otherwise specified, shall be mechanically applied in a factory or plant especially equipped for the purpose. The materials shall, unless otherwise indicated on the drawings, consist of one of the following for the indicated pipe material and size:

- a. Pipe and fittings less than 80 mm (3 inches) in diameter shall be thoroughly cleaned of foreign material by wire brushing and solvent cleaning, and then given 1 coat of coal-tar primer and 2 coats of coal-tar enamel conforming to AWWA C203; threaded ends of pipe and fittings shall be adequately protected prior to coating.
- b. Pipe 80 mm (3 Inches) or Larger, Not Galvanized:
  - (1) Cement-mortar coating and lining shall conform to and shall be applied in conformance with AWWA C205. Cement-mortar coating and linings shall not be used for pipe less than 100 mm (4 inches) in diameter.

(2) Coal-tar enamel lining, coating and wrapping shall conform to AWWA C203 for materials, method of application, tests and handling. Non-asbestos material shall be used for the outerwrap.

(3) Cement-mortar lining, in lieu of coal-tar enamel lining, may be used with coal-tar enamel coating and wrapping. Cement-mortar lining shall conform to and shall be applied in conformance with AWWA C205.

#### 2.1.7 Copper Tubing

Copper tubing shall conform to ASTM B 88M, Type K, annealed.

### 2.2 FITTINGS AND SPECIALS

#### 2.2.1 Reinforced Concrete Pipe System

Fittings and specials required for closures, curves, bends, branches and connections to valves, pipe, or structures shall be approved by the Contracting Officer and conform to the details furnished by the manufacturer and to AWWA C300, AWWA C301, or AWWA C303, as applicable.

#### 2.2.2 PVC Pipe System

- a. For pipe less than 100 mm (4 inch) diameter, fittings for threaded pipe shall conform to requirements of ASTM D 2464, threaded to conform to the requirements of ASME B1.20.1 for use with Schedule 80 pipe and fittings; fittings for solvent cement jointing shall conform to ASTM D 2466 or ASTM D 2467; and fittings for elastomeric-gasket joint pipe shall be iron conforming to AWWA C110 or AWWA C111. Iron fittings and specials shall be cement-mortar lined (standard thickness) in accordance with AWWA C104.
- b. For pipe 100 mm (4 inch) diameter and larger, fittings and specials shall be iron, bell end in accordance with AWWA C110, 1.03 MPa (150 psi) pressure rating unless otherwise shown or specified, except that profile of bell may have special dimensions as required by the pipe manufacturer; or fittings and specials may be of the same material as the pipe with elastomeric gaskets, all in conformance with AWWA C900. Iron fittings and specials shall be cement-mortar lined (standard thickness) in accordance with AWWA C104. Fittings shall be bell and spigot or plain end pipe, or as applicable. Ductile iron compact fittings shall be in accordance with AWWA C153.

#### 2.2.3 RTRP and RPMP Pipe

Fittings and specials shall be compatible with the pipe supplied. Filament wound or molded fittings up to 150 mm (6 inches) shall conform to AWWA C950.

Iron fittings shall be cement-mortar lined in accordance with AWWA C104 and shall conform to AWWA C110 and AWWA C111. Fittings shall be suitable for working and testing pressures specified for the pipe.

#### 2.2.4 Ductile-Iron Pipe System

Fittings and specials shall be suitable for 1.03 MPa (150 psi) pressure rating, unless otherwise specified. Fittings and specials for mechanical joint pipe shall conform to AWWA C110. Fittings and specials for use with push-on joint pipe shall conform to AWWA C110 and AWWA C111. Fittings and specials for grooved and shouldered end pipe shall conform to AWWA C606. Fittings and specials shall be cement-mortar lined (standard thickness) in accordance with AWWA C104. Ductile iron compact fittings shall conform to AWWA C153.

#### 2.2.5 Steel Pipe System

##### 2.2.5.1 Not Galvanized Steel Pipe

Fittings and specials shall be made of the same material as the pipe. Specials and fittings may be made of standard steel tube turns or segmentally welded sections, with ends to accommodate the type of couplings or joints specified for the pipe. Dimensions of steel pipe fittings shall be in accordance with AWWA C208. The thickness and pressure rating of pipe fittings and specials shall be not less than the thickness specified and the pressure rating calculated for the pipe with which they are used. Protective materials for fittings and specials shall be as specified for the pipe. Specials and fittings that cannot be mechanically lined, coated, and wrapped shall be lined, coated, and wrapped by hand, using the same material used for the pipe with the same number of applications of each material, smoothly applied.

##### 2.2.5.2 Galvanized Steel Piping

Steel fittings shall be galvanized. Screwed fittings shall conform to ASME B16.3. Flanged fittings shall conform to AWWA C207.

##### 2.2.5.3 Dielectric Fittings

Dielectric fittings shall be installed between threaded ferrous and nonferrous metallic pipe, fittings and valves, except where corporation stops join mains. Dielectric fittings shall prevent metal-to-metal contact of dissimilar metallic piping elements and shall be suitable for the required working pressure.

#### 2.2.6 Copper Tubing System

Fittings and specials shall be flared and conform to ASME B16.26.

### 2.3 JOINTS

#### 2.3.1 Gaskets for Reinforced Concrete Pipe

Rubber-gasket joints shall be of the type using a bell-and-spigot joint design of steel. The gaskets shall conform to AWWA C300, AWWA C301, or AWWA C303, as applicable.

#### 2.3.2 Plastic Pipe Jointing



#### 2.3.2.1 PE Pipe

Joints for pipe fittings and couplings shall be strong tight joints as specified for PE in Paragraph INSTALLATION. Joints connecting pipe of differing materials shall be made in accordance with the manufacturer's recommendation, and as approved by the Contracting Officer.

#### 2.3.2.2 PVC Pipe

Joints, fittings, and couplings shall be as specified for PVC pipe. Joints connecting pipe of differing materials shall be made in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer.

#### 2.3.2.3 PVCO Pipe

Joints shall conform to ASTM D 3139. Elastomeric gaskets shall conform to ASTM F 477.

#### 2.3.3 RPMP Pipe

Joints shall be bell and spigot gasket coupling utilizing an elastomeric gasket in accordance with ASTM D 4161.

#### 2.3.4 RTRP Pipe

##### 2.3.4.1 RTRP-I, Grade 1 and 2

Joints shall be bell and spigot with elastomeric gasket, mechanical coupling with elastomeric gasket, threaded and bonded coupling, or tapered bell and spigot with compatible adhesive. All RTRP-I materials shall be products of a single manufacturer.

##### 2.3.4.2 RTRP-II, Grade 1 and 2

Joints shall be the bell and spigot type with elastomeric gasket, bell and spigot with adhesive, butt-jointed with adhesive bonded reinforced overlay, mechanical, flanged, threaded or commercially available proprietary joints, provided they are capable of conveying water at the pressure and temperature of the pipe.

#### 2.3.5 Ductile-Iron Pipe Jointing

- a. Mechanical joints shall be of the stuffing box type and shall conform to AWWA C111.
- b. Push-on joints shall conform to AWWA C111.
- c. Rubber gaskets and lubricants shall conform to the applicable requirements of AWWA C111.

#### 2.3.6 Steel Pipe Jointing

##### 2.3.6.1 Steel Pipe, Not Galvanized

- a. Mechanical couplings shall be as specified.
- b. Bell-and-spigot joints for use with rubber gaskets shall conform to AWWA C200, as appropriate for the type of pipe. Rubber gaskets shall conform to applicable requirements of AWWA C200.
- c. Flanges shall conform to AWWA C207, and shall be used only in above ground installation or where shown on the drawings, or when approved.

#### 2.3.6.2 Mechanical Couplings

Mechanical couplings for steel pipe shall be the sleeve type, or when approved, the split-sleeve type and shall provide a tight flexible joint under all reasonable conditions, such as pipe movements caused by expansion, contraction, slight setting or shifting in the ground, minor variations in trench gradients, and traffic vibrations. Couplings shall be of strength not less than the adjoining pipeline.

#### 2.3.7 Bonded Joints

Where indicated, a metallic bond shall be provided at each joint, including joints made with flexible couplings, caulking, or rubber gaskets, of ferrous metallic piping to effect continuous conductivity. The bond wire shall be Size 1/0 copper conductor suitable for direct burial shaped to stand clear of the joint. The bond shall be of the thermal weld type.

#### 2.3.8 Isolation Joints

Isolation joints shall be installed between nonthreaded ferrous and nonferrous metallic pipe, fittings and valves. Isolation joints shall consist of a sandwich-type flange isolation gasket of the dielectric type, isolation washers, and isolation sleeves for flange bolts. Isolation gaskets shall be full faced with outside diameter equal to the flange outside diameter. Bolt isolation sleeves shall be full length. Units shall be of a shape to prevent metal-to-metal contact of dissimilar metallic piping elements.

- a. Sleeve-type couplings shall be used for joining plain end pipe sections. The two couplings shall consist of one steel middle ring, two steel followers, two gaskets, and the necessary steel bolts and nuts to compress the gaskets.
- b. Split-sleeve type couplings may be used in aboveground installations when approved in special situations and shall consist of gaskets and a housing in two or more sections with the necessary bolts and nuts.

#### 2.3.9 Copper Tubing Jointing

Joints shall be compression-pattern flared and shall be made with the specified fittings.

## 2.4 VALVES

### 2.4.1 Check Valves

Check valves shall be designed for a minimum working pressure of 1.03 MPa (150 psi) or as indicated. Valves shall have a clear waterway equal to the full nominal diameter of the valve. Valves shall open to permit flow when inlet pressure is greater than the discharge pressure, and shall close tightly to prevent return flow when discharge pressure exceeds inlet pressure. The size of the valve, working pressure, manufacturer's name, initials, or trademark shall be cast on the body of each valve. Valves 50 mm (2 inches) and larger shall be outside lever and spring type.

- a. Valves 50 mm (2 inches) and smaller shall be all bronze designed for screwed fittings, and shall conform to MSS SP-80, Class 150, Types 3 and 4 as suitable for the application.
- b. Valves larger than 50 mm (2 inches) shall be iron body, bronze mounted, shall have flanged ends, and shall be the non-slam type. Flanges shall be the Class 125 type conforming to ASME B16.1.

### 2.4.2 Gate Valves

Gate valves shall be designed for a working pressure of not less than 1.03 MPa (150 psi). Valve connections shall be as required for the piping in which they are installed. Valves shall have a clear waterway equal to the full nominal diameter of the valve, and shall be opened by turning counterclockwise. The operating nut or wheel shall have an arrow, cast in the metal, indicating the direction of opening.

- a. Valves smaller than 80 mm (3 inches) shall be all bronze and shall conform to MSS SP-80, Type 1, Class 150.
- b. Valves 80 mm (3 inches) and larger shall be iron body, bronze mounted, and shall conform to AWWA C500. Flanges shall not be buried. An approved pit shall be provided for all flanged connections.
- c. Resilient-Seated Gate Valves: For valves 80 to 300 mm (3 to 12 inches) in size, resilient-seated gate valves shall conform to AWWA C509.

### 2.4.3 Rubber-Seated Butterfly Valves

Rubber-seated butterfly valves shall conform to the performance requirements of AWWA C504. Wafer type valves conforming to the performance requirements of AWWA C504 in all respects, but not meeting laying length requirements will be acceptable if supplied and installed with a spacer providing the specified laying length. All tests required by AWWA C504 shall be met. Flanged-end valves shall be installed in an approved pit and provided with a union or sleeve-type coupling in the pit to permit removal.

Mechanical-end valves 80 through 250 mm in diameter may be direct burial if provided with a suitable valve box, means for manual operation, and an adjacent pipe joint to facilitate valve removal. Valve operators shall

restrict closing to a rate requiring approximately 60 seconds, from fully open to fully closed.

#### 2.4.4 Pressure Reducing Valves

Pressure reducing valves shall maintain a constant downstream pressure regardless of fluctuations in demand. Valves shall be suitable for 1.03 MPa (150 psi) operating pressure on the inlet side, with outlet pressure set for 1.03 MPa (150 psi). The valves shall be of the hydraulically-operated, pilot controlled, globe or angle type, and may be actuated either by diaphragm or piston. The pilot control shall be the diaphragm-operated, adjustable, spring-loaded type, designed to permit flow when controlling pressure exceeds the spring setting. Ends shall be flanged. Valve bodies shall be bronze, cast iron or cast steel with bronze trim. Valve stem shall be stainless steel. Valve discs and diaphragms shall be synthetic rubber. Valve seats shall be bronze. Pilot controls shall be bronze with stainless steel working parts.

#### 2.4.5 Vacuum and Air Relief Valves

Vacuum and air relief valves shall be of the sizes shown and shall be of a type that will release air and prevent the formation of a vacuum. The valves shall automatically release air when the lines are being filled with water and shall admit air into the line when water is being withdrawn in excess of the inflow. Valves shall be iron body with bronze trim and stainless steel float.

#### 2.4.6 Indicator Post for Valves

Each valve shown on the drawings with the designation "P.I.V." shall be equipped with indicator post conforming to the requirements of NFPA 24. Operation shall be by a wrench which shall be attached to each post.

### 2.5 VALVE BOXES

Valve boxes shall be cast iron or concrete, except that concrete boxes may be installed only in locations not subjected to vehicular traffic. Cast-iron boxes shall be extension type with slide-type adjustment and with flared base. The minimum thickness of metal shall be 5 mm. Concrete boxes shall be the standard product of a manufacturer of precast concrete equipment. The word "WATER" shall be cast in the cover. The box length shall adapt, without full extension, to the depth of cover required over the pipe at the valve location.

### 2.6 VALVE PITS

Valve pits shall be constructed at locations indicated or as required above and in accordance with the details shown. Concrete shall have compressive strength of 21 MPa in accordance with Section 03301 CAST-IN-PLACE STRUCTURAL CONCRETE.

### 2.7 MISCELLANEOUS ITEMS

#### 2.7.1 Service Clamps

Service clamps shall have a pressure rating not less than that of the pipe to be connected and shall be either the single or double flattened strap type. Clamps shall have a galvanized malleable-iron body with cadmium plated straps and nuts. Clamps shall have a rubber gasket cemented to the body.

#### 2.7.2 Corporation Stops

Corporation stops shall have standard corporation stop thread conforming to AWWA C800 on the inlet end, with flanged joints, compression pattern flared tube couplings, or wiped joints for connections to goosenecks.

#### 2.7.3 Goosenecks

Copper tubing for gooseneck connections shall conform to the applicable requirements of ASTM B 88M, Type K, annealed. Length of cable requirement connections shall be in accordance with standard practice.

#### 2.7.4 Service Stops

Service stops shall be water-works inverted-ground-key type, oval or round flow way, tee handle, without drain. Pipe connections shall be suitable for the type of service pipe used. All parts shall be of bronze with female iron-pipe-size connections or compression-pattern flared tube couplings, and shall be designed for a hydrostatic test pressure not less than 1.375 MPa (200 psi).

#### 2.7.5 Tapping Sleeves

Tapping sleeves of the sizes indicated for connection to existing main shall be the cast gray, ductile, or malleable iron, split-sleeve type with flanged or grooved outlet, and with bolts, follower rings and gaskets on each end of the sleeve. Construction shall be suitable for a maximum working pressure of 1.03 MPa (150 psi). Bolts shall have square heads and hexagonal nuts. Longitudinal gaskets and mechanical joints with gaskets shall be as recommended by the manufacturer of the sleeve. When using grooved mechanical tee, it shall consist of an upper housing with full locating collar for rigid positioning which engages a machine-cut hole in pipe, encasing an elastomeric gasket which conforms to the pipe outside diameter around the hole and a lower housing with positioning lugs, secured together during assembly by nuts and bolts as specified, pretorqued to 67.8 Newton meters (50 foot-pound).

#### 2.7.6 Service Boxes

Service boxes shall be cast iron or concrete and shall be extension service boxes of the length required for the depth of the line, with either screw or slide-type adjustment. The boxes shall have housings of sufficient size to completely cover the service stop or valve and shall be complete with identifying covers.

#### 2.7.7 Disinfection

Chlorinating materials shall conform to the following:

Chlorine, Liquid: AWWA B301.

Hypochlorite, Calcium and Sodium: AWWA B300.

#### 2.7.8 Meters

Meters shall be the type and size shown on the drawings or specified. Meters of each of the various types furnished and installed shall be supplied by one manufacturer.

##### 2.7.8.1 Displacement Type

Displacement type meters shall conform to AWWA C700. Registers shall be straight-reading and shall read in cubic meters. Meters in sizes 13 through 25 mm shall be frost-protection design. Connections shall be suitable to the type of pipe and conditions encountered. Register type shall be a direct reading remote register designed in accordance with AWWA C706 or an encoder type remote register designed in accordance with AWWA C707. Meters shall comply with the accuracy and capacity requirements of AWWA C700.

##### 2.7.8.2 Turbine Type

Turbine type meters shall conform to AWWA C701 Class I or Class II. The main casing shall be bronze with stainless steel external fasteners. Registers shall be straight-reading type, shall be permanently sealed and shall read in cubic meters. Connections shall be suitable to the type of pipe and conditions encountered. Register type shall be a direct reading remote register designed in accordance with AWWA C706 or an encoder type remote register designed in accordance with AWWA C707. Meters shall comply with the accuracy and capacity requirements of AWWA C701.

##### 2.7.8.3 Compound Type

Compound type meters shall conform to AWWA C702 and shall be furnished with strainers. The main casing shall be bronze with stainless steel external fasteners. The main casing shall be tapped for field testing purposes. Registers shall be straight-reading type, shall be permanently sealed and shall read in cubic meters. The meter shall be equipped with a coordinating register. Connections shall be suitable to the type of pipe and conditions encountered. Register type shall be a direct reading remote register designed in accordance with AWWA C706 or an encoder type remote register designed in accordance with AWWA C707. Meters shall comply with the accuracy and capacity requirements of AWWA C702.

##### 2.7.8.4 Propeller Type

Propeller type meters shall conform to AWWA C704. Registers shall be straight-reading type, shall be permanently sealed and shall read in cubic meters. Connections shall be suitable to the type of pipe and conditions encountered. Register type shall be a direct-reading remote register designed in accordance with AWWA C706 or an encoder-type remote register

designed in accordance with AWWA C707. Meters shall comply with the accuracy and capacity requirements of AWWA C703.

#### 2.7.9 Meter Boxes

Meter boxes shall be of cast iron, concrete, or plastic. The boxes shall be of sufficient size to completely enclose the meter and shutoff valve or service stop. Meter boxes set in paved areas subject to vehicular traffic shall be cast iron, or concrete with cast iron lid and cast iron meter reader lid. Boxes set in sidewalks, not subject to vehicular traffic, shall use concrete covers with cast iron meter reader lids. Plastic boxes and lids shall be used in unpaved areas or grass areas not subject to vehicular traffic. Box height shall extend from invert of the meter to final grade at the meter location. The lid shall have the word "WATER" cast in it.

#### 2.8 METER VAULTS

Large meters shall be installed in reinforced concrete vaults in accordance with the details shown on the drawings.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

##### 3.1.1 Cutting of Pipe

Cutting of pipe shall be done in a neat and workmanlike manner without damage to the pipe. Unless otherwise recommended by the manufacturer and authorized by the Contracting Officer, cutting shall be done with an approved type mechanical cutter. Wheel cutter shall be used when practicable. Copper tubing shall be cut square and all burrs shall be removed. Squeeze type mechanical cutters shall not be used for ductile iron.

##### 3.1.2 Adjacent Facilities

###### 3.1.2.1 Sewer Lines

Where the location of the water pipe is not clearly defined in dimensions on the drawings, the water pipe shall not be laid closer horizontally than 3 m from a sewer except where the bottom of the water pipe will be at least 300 mm above the top of the sewer pipe, in which case the water pipe shall not be laid closer horizontally than 1.8 m from the sewer. Where water lines cross under gravity-flow sewer lines, the sewer pipe, for a distance of at least 3 m each side of the crossing, shall be fully encased in concrete or shall be made of pressure pipe with no joint located within 900 mm horizontally of the crossing. Water lines shall in all cases cross above sewage force mains or inverted siphons and shall be not less than 600 mm above the sewer main. Joints in the sewer main, closer horizontally than 900 mm to the crossing, shall be encased in concrete.

###### 3.1.2.2 Water Lines

Water lines shall not be laid in the same trench with sewer lines, gas lines, fuel lines, or electric wiring.

#### 3.1.2.3 Copper Tubing Lines

Copper tubing shall not be installed in the same trench with ferrous piping materials.

#### 3.1.2.4 Nonferrous Metallic Pipe

Where nonferrous metallic pipe, e.g. copper tubing, crosses any ferrous piping material, a minimum vertical separation of 300 mm shall be maintained between pipes.

#### 3.1.2.5 Casing Pipe

Water pipe shall be encased in a sleeve of rigid conduit for the lengths shown. Sleeves under reinforced concrete channel inverts shall be in accordance with the criteria contained in the drawings. Where sleeves are required, in all other cases, the pipe sleeve shall be steel, manufactured in accordance with AWWA C200 or ASTM A 36/A 36M, with a minimum wall thickness of 13 mm. A minimum clearance of at least 50 mm between the inner wall of the sleeve and the maximum outside diameter of the sleeved pipe and joints shall be provided. Sand bedding or suitable pipe support shall be provided for the water pipe through the sleeve. Sleeves of ferrous material shall be provided with corrosion protection as required in Section 05502 MISCELLANEOUS METAL.

#### 3.1.2.6 Structures

Where water pipe is required to be installed within 1 m of existing structures, the water pipe shall be sleeved as required in Paragraph "Casing Pipe". The Contractor shall install the water pipe and sleeve ensuring that there will be no damage to the structures and no settlement or movement of foundations or footings.

#### 3.1.3 Joint Deflection

##### 3.1.3.1 Allowable for Reinforced Concrete Pipe

Maximum allowable deflections from a straight line or grade, as required by vertical curves, horizontal curves, or offsets, shall be 5 degrees for reinforced concrete pipe unless a lesser amount is recommended by the manufacturer. Long radius curves in reinforced concrete pipe shall be formed by straight pipe in which spigot rings are placed on a bevel. Slight deflections may be made by straight pipe, provided that the maximum joint opening caused by such deflection does not exceed the maximum recommended by the pipe manufacturer. Short radius curves and closures shall be formed by shorter lengths of pipe, bevels, or fabricated specials specified.

##### 3.1.3.2 Offset for Flexible Plastic Pipe

Maximum offset in alignment between adjacent pipe joints shall be as



recommended by the manufacturer and approved by the Contracting Officer, but shall not exceed 5 degrees.

#### 3.1.3.3 Allowable for Ductile-Iron Pipe

The maximum allowable deflection shall be as given in AWWA C600. If the alignment requires deflection in excess of the above limitations, special bends or a sufficient number of shorter lengths of pipe shall be furnished to provide angular deflections within the limit set forth.

#### 3.1.3.4 Allowable for Steel Pipe

For pipe with bell-and-spigot rubber-gasket joints, maximum allowable deflections from a straight line or grade, as required by vertical curves, horizontal curves, or offsets shall be 5 degrees unless a lesser amount is recommended by the manufacturer. Short-radius curves and closures shall be formed by short lengths of pipe or fabricated specials specified.

#### 3.1.3.5 Allowable for RPMP Pipe

For pipe with bell and spigot rubber gasket joints, maximum allowable deflections from a straight line or grade shall be 4 degrees determined by the diameter, unless a lesser amount is recommended by the manufacturer. Short-radius curves and closures shall be formed by short lengths of pipe or fabricated specials specified.

#### 3.1.4 Placing and Laying

Pipe and accessories shall be carefully lowered into the trench by means of derrick, ropes, belt slings, or other authorized equipment. Water-line materials shall not be dropped or dumped into the trench. Abrasion of the pipe coating shall be avoided. Except where necessary in making connections with other lines or as authorized by the Contracting Officer, pipe shall be laid with the bells facing in the direction of laying. The full length of each section of pipe shall rest solidly upon the pipe bed, with recesses excavated to accommodate bells, couplings, and joints. Pipe that has the grade or joint disturbed after laying shall be taken up and relaid. Pipe shall not be laid in water or when trench conditions are unsuitable for the work. Water shall be kept out of the trench until joints are complete. When work is not in progress, open ends of pipe, fittings, and valves shall be securely closed so that no trench water, earth, or other substance will enter the pipes or fittings. Where any part of the coating or lining is damaged, the repair shall be made by and at the Contractor's expense in a satisfactory manner. Pipe ends left for future connections shall be valved, plugged, or capped, and anchored, as shown.

##### 3.1.4.1 Reinforced Concrete Pipe Installation

Reinforced concrete pipe shall be installed in accordance with recommendations of the pipe manufacturer. Before laying reinforced concrete pipe, the outside surface of the spigot and the inside surface of the bell shall be cleaned and an acceptable vegetable-compound lubricant applied to the inside surface of the bell and to the rubber gasket. Where prescribed by the pipe manufacturer, the gasket shall be placed in the

groove on the end of the pipe before the pipe is placed in the trench. After the pipe has been forced together, the position of the rubber gasket shall be checked with a feeler gauge in accordance with the pipe manufacturer's recommendations. Tapping of reinforced concrete cylinder pipe shall be done in accordance with the manufacturer's approved recommendations. Where the manufacturer recommends that the taps be made by attaching the rubber-gasketed saddle to the outside of the pipe using U-bolts, the saddle shall be grouted in if necessary, the mortar coating shall be chipped away, even with the hole in the saddle plate. The exposed circumferential wires shall be removed and the cylinder and concrete core drilled out, and the steel saddle and U-bolts shall be protected by concrete encasement.

#### 3.1.4.2 Plastic Pipe Installation

RTRP shall be installed in accordance with ASTM D 3839. RPMP shall be installed in accordance with the manufacturer's recommendations. PE Pipe shall be installed in accordance with ASTM D 2774. PVC pipe shall be installed in accordance with AWWA M23.

#### 3.1.4.3 Piping Connections

Where connections are made between new work and existing mains, the connections shall be made by using specials and fittings to suit the actual conditions. When made under pressure, these connections shall be installed using standard methods as approved by the Contracting Officer. Connections to existing asbestos-cement pipe shall be made in accordance with ACPPA Work Practices.

#### 3.1.4.4 Penetrations

Pipe passing through walls of valve pits and structures shall be provided with ductile-iron or Schedule 40 steel wall sleeves. Annular space between walls and sleeves shall be filled with rich cement mortar. Annular space between pipe and sleeves shall be filled with mastic.

#### 3.1.4.5 Flanged Pipe

Flanged pipe shall only be installed above ground or with the flanges in valve pits.

#### 3.1.5 Jointing

##### 3.1.5.1 Reinforced Concrete Pipe Requirements

The inside and outside annular spaces between abutting sections of concrete pipe shall be filled with rich cement mortar in accordance with the pipe manufacturer's recommendations. Excess mortar shall be removed from interior annular spaces, leaving a smooth and continuous surface between pipe sections. Exposed portions of steel joint rings shall be protected from corrosion by a metallic coating or by an approved nonmetallic coating.

Rubber gaskets shall be handled, lubricated where necessary, and installed in accordance with the pipe manufacturer's recommendations.

### 3.1.5.2 PE Pipe Requirements

Jointing shall comply with ASTM D 2657, Technique I-Socket Fusion or Technique II-Butt Fusion.

### 3.1.5.3 PVC Plastic Pipe Requirements

- a. Pipe less than 100 mm (4 inch) diameter: Threaded joints shall be made by wrapping the male threads with approved thread tape or applying an approved lubricant, then threading the joining members together. The joint shall be tightened using strap wrenches to prevent damage to the pipe and/or fitting. To avoid excessive torque, joints shall be tightened no more than one thread past hand-tight. Preformed rubber-ring gaskets for elastomeric-gasket joints shall be made in accordance with ASTM F 477 and as specified. Pipe ends for push-on joints shall be beveled to facilitate assembly and marked to indicate when the pipe is fully seated. The gasket shall be prelubricated to prevent displacement. The gasket and ring groove in the bell or coupling shall match. The manufacturer of the pipe or fitting shall supply the elastomeric gasket. Couplings shall be provided with stops or centering rings to assure that the coupling is centered on the joint. Solvent cement joints shall use sockets conforming to ASTM D 2467. The solvent cement used shall meet the requirements of ASTM D 2564; the joint assembly shall be made in accordance with ASTM D 2855 and the manufacturer's specific recommendations.
- b. Pipe 100 through 300 mm diameter: Joints shall be elastomeric gasket as specified in AWWA C900. Jointing procedure shall be as specified for pipe less than 100 mm (4 inch) diameter with configuration using elastomeric ring gasket.
- c. Pipe 350 through 900 mm diameter: Joints shall be elastomeric gasket push-on joints made in accordance with AWWA M23.

### 3.1.5.4 RTRP I, RTRP II and RPMP Pipe

- a. RTRP I: Assembly of the pipe shall be done in conformance with the manufacturer's written instruction and installation procedures. Field joints shall be prepared as specified by the pipe manufacturer. Several pipe joints having interference-fit type couplings may be field bonded and cured simultaneously. However, the pipe shall not be moved and additional joints shall not be made until the previously laid joints are completely cured. Joints not having interference-fit type coupling shall be fitted with a clamp which shall hold the joint rigidly in place until the joint cement has completely cured. The clamps shall have a protective material on the inner surface to prevent damage to the plastic pipe when the clamp is tightened in place. The pipe manufacturer shall provide a device or method to determine when the joint is pulled against the pipe stop. Additionally, the pipe manufacturer shall furnish a gauge to measure the diameter of the spigot ends to ensure the diameter conforms to the tolerances specified by the manufacturer. All pipe ends shall be gauged.

Factory certified tests shall have been satisfactorily performed to verify that short-term rupture strength is 10.3 MPa (1,500 psi) or greater when carried out in accordance with ASTM D 1599. At any ambient temperature, field bonded epoxy-cemented joints shall be cured with a self-regulating, thermostatically temperature controlled, electrical heating blanket for the time and temperature recommended by the manufacturer for the applicable size and type of joint, or by an alternate heating method recommended by the manufacturer and approved by the Contracting Officer. The joint sections shall not be moved during heating, or until the joint has cooled to ambient temperature.

- b. RTRP II: A reinforced overlay joint shall be used to join sections together through a placement of layers of reinforcement fiberglass roving, mat, tape or fabric thoroughly saturated with compatible catalyzed resin.
- c. RPMP: Bell and spigot gasket-sealing coupling shall be used to connect pipes. The spigot shall be lubricated prior to push-together assembly.
- d. Fittings and Specials for RTRP and RPMP Pipe: Metal to RTRP and RPMP pipe connections shall be made by bolting steel flanges to RTRP and RPMP pipe flanges. Cast-iron fitting with gasket bell or mechanical joint may be used with RTRP if pipe has cast iron outside diameter. Steel flanges shall be flat-faced type. Where raised-face steel flanges are used, spacer rings shall be used to provide a flat-face seat for RTRP and RPMP pipe flanges. A full-face Buna "N" gasket 3 mm (1/8 inch) thick with a shore hardness of 50-60 shall be used between all flanged connections. The RTRP and RPMP pipe flange shall have raised sealing rings. Flat washers shall be used under all nuts and bolts on RTRP and RPMP pipe flanges. Bolts and nuts shall be of noncorrosive steel and torqued to not more than 135 Newton meters. Flanges shall not be buried. A concrete pit shall be provided for all flanged connections.

#### 3.1.5.5 Ductile-Iron Pipe Requirements

Mechanical and push-on type joints shall be installed in accordance with AWWA C600 for buried lines or AWWA C606 for grooved and shouldered pipe above ground or in pits.

#### 3.1.5.6 Not Galvanized Steel Pipe Requirements

- a. Mechanical Couplings: Mechanical couplings shall be installed in accordance with the recommendations of the couplings manufacturer.
- b. Rubber Gaskets: Rubber gaskets shall be handled, lubricated where necessary, and installed in accordance with the pipe manufacturer's recommendations.

#### 3.1.5.7 Galvanized Steel Pipe Requirements

Screw joints shall be made tight with a stiff mixture of graphite and oil, inert filler and oil, or with an approved graphite compound, applied with a brush to the male threads only. Compounds shall not contain lead.

#### 3.1.5.8 Copper Tubing Requirements

Joints shall be made with flared fittings. The flared end tube shall be pulled tightly against the tapered part of the fitting by a nut which is part of the fitting, so there is metal-to-metal contact.

#### 3.1.5.9 Bonded Joints Requirements

Bonded joints shall be installed in accordance with details specified for joints in paragraph JOINTS.

#### 3.1.5.10 Isolation Joints and Dielectric Fittings

Isolation joints and dielectric fittings shall be installed in accordance with details specified in paragraph JOINTS. Dielectric unions shall be encapsulated in a field-poured coal-tar covering, with at least 3 mm thickness of coal tar over all fitting surfaces.

#### 3.1.5.11 Transition Fittings

Connections between different types of pipe and accessories shall be made with transition fittings approved by the Contracting Officer.

#### 3.1.6 Field Coating and Lining of Pipe

##### 3.1.6.1 Steel Pipe 80 mm (3 In.) and Larger, Not Galvanized

- a. Cement-mortar coating and lining: Field jointing shall conform to Appendix, AWWA C205. Any defective area found in the coating and/or lining of pipe and joints shall be removed to the pipe wall and repaired. The repaired areas shall be at least equal in thickness to the minimum coating and/or lining required for the pipe. Steel reinforcement in the coating shall be repaired or replaced as necessary to assure a complete and soundly reinforced coating.
- b. Coal-tar enamel coating, lining and wrapping: Field jointing shall conform to AWWA C203. The applied materials shall be tested by means of a spark-type electrical inspection device in accordance with the requirements of AWWA C203. Any flaws or holidays found in the coating and/or lining of pipe and joints shall be repaired by patching or other approved means. The repaired areas shall be at least equal in thickness to the minimum coating and/or lining required for the pipe.

##### 3.1.6.2 Galvanized Steel Pipe, Field Coating

Field joints shall be given 1 coat of coal-tar primer and 2 coats of coal-tar enamel conforming to AWWA C203. The tests of the coating shall conform to AWWA C203, and any flaws or holidays found in the coating of

pipe and joints shall be repaired by patching or other approved means; the repaired areas shall be at least equal in thickness to the minimum coating required for the pipe.

### 3.1.7 Setting of Meters, Valves and Valve Boxes

#### 3.1.7.1 Location of Meters

Meters and meter boxes and/or vaults shall be installed at the locations shown on the drawings. The meters shall be centered in the boxes or vaults to allow for reading and ease of removal or maintenance.

#### 3.1.7.2 Location of Valves

After delivery, valves, including those in hydrants, shall be drained to prevent freezing and shall have the interiors cleaned of all foreign matter before installation. Stuffing boxes shall be tightened and hydrants and valves shall be fully opened and fully closed to ensure that all parts are in working condition. Check, pressure reducing, vacuum, and air relief valves shall be installed in valve pits. Valves and valve boxes shall be installed where shown or specified, and shall be set plumb. Valve boxes shall be centered on the valves. Boxes shall be installed over each outside gate valve unless otherwise shown. Where feasible, valves shall be located outside the area of roads and streets. Earth fill shall be tamped around each valve box or pit to a distance of 1.2 m on all sides of the box, or the undisturbed trench face if less than 1.2 m.

#### 3.1.7.3 Location of Service Boxes

Where water lines are located below paved streets having curbs, the boxes shall be installed directly back of the curbs. Where no curbing exists, service boxes shall be installed in accessible locations, beyond the limits of street surfacing, walks and driveways.

### 3.1.8 Tapped Tees and Crosses

Tapped tees and crosses for future connections shall be installed where shown.

### 3.1.9 Thrust Restraint

Plugs, caps, tees and bends deflecting 11.25 degrees or more, either vertically or horizontally, on waterlines 100 mm (4 inches) in diameter or larger, and fire hydrants shall be provided with thrust restraints. Valves shall be securely anchored or shall be provided with thrust restraints to prevent movement. Thrust restraints shall be either thrust blocks or, for ductile-iron pipes, restrained joints.

#### 3.1.9.1 Thrust Blocks

Thrust blocking shall be concrete of a mix not leaner than: 1 cement, 2-1/2 sand, 5 gravel; and having a compressive strength of not less than 14 MPa after 28 days. Blocking shall be placed between solid ground and the hydrant or fitting to be anchored. Unless otherwise indicated or directed,

the base and thrust bearing sides of thrust blocks shall be poured directly against undisturbed earth. The sides of thrust blocks not subject to thrust may be poured against forms. The area of bearing shall be as shown or as directed. Blocking shall be placed so that the fitting joints will be accessible for repair. Steel rods and clamps, protected by galvanizing or by coating with bituminous paint, shall be used to anchor vertical down bends into gravity thrust blocks.

#### 3.1.9.2 Restrained Joints

For ductile-iron pipe, restrained joints shall be designed by the Contractor or the pipe manufacturer in accordance with DIPRA-Restraint Design.

### 3.2 HYDROSTATIC TESTS

Where any section of a water line is provided with concrete thrust blocking for fittings or hydrants, the hydrostatic tests shall not be made until at least 5 days after installation of the concrete thrust blocking, unless otherwise approved. Prior to commencing the hydrostatic tests, the Contractor shall submit a Waste Water Disposal Method to the Contracting Officer.

#### 3.2.1 Pressure Test

After the pipe is laid, the joints completed, and the trench partially backfilled leaving the joints exposed for examination, the newly laid piping or any valved section of piping shall, unless otherwise specified, be subjected for 1 hour to a hydrostatic pressure test of 1.38 MPa (200 psi).

Water supply lines designated on the drawings shall be subjected for 1 hour to a hydrostatic pressure test of 1.38 MPa (200 psi). Each valve shall be opened and closed several times during the test. Exposed pipe, joints, fittings, hydrants, and valves shall be carefully examined during the partially open trench test. Joints showing visible leakage shall be replaced or remade as necessary. Cracked or defective pipe, joints, fittings, hydrants and valves discovered in consequence of this pressure test shall be removed and replaced with sound material, and the test shall be repeated until the test results are satisfactory. The requirement for the joints to remain exposed for the hydrostatic tests may be waived by the Contracting Officer when one or more of the following conditions is encountered:

- a. Wet or unstable soil conditions in the trench.
- b. Compliance would require maintaining barricades and walkways around and across an open trench in a heavily used area that would require continuous surveillance to assure safe conditions.
- c. Maintaining the trench in an open condition would delay completion of the project.

The Contractor may request a waiver, setting forth in writing the reasons for the request and stating the alternative procedure proposed to comply with the required hydrostatic tests. Backfill placed prior to the tests

shall be placed in accordance with the requirements of Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.

### 3.2.2 Leakage Test

Leakage test shall be conducted after the pressure tests have been satisfactorily completed. The duration of each leakage test shall be at least 2 hours, and during the test the water line shall be subjected to not less than 1.38 MPa (200 psi) pressure. Water supply lines designated on the drawings shall be subjected to a pressure equal to 1.38 MPa (200 psi). Leakage is defined as the quantity of water to be supplied into the newly laid pipe, or any valved or approved section, necessary to maintain pressure within 34.5 kPa (5 psi) of the specified leakage test pressure after the pipe has been filled with water and the air expelled. Piping installation will not be accepted if leakage exceeds the allowable leakage which is determined by the following formula:

$$L = 0.0001351ND(P \text{ raised to } 0.5 \text{ power})$$

L = Allowable leakage in gallons per hour

N = Number of joints in the length of pipeline tested

D = Nominal diameter of the pipe in inches

P = Average test pressure during the leakage test, in psi gauge

Should any test of pipe disclose leakage greater than that calculated by the above formula, the defective joints shall be located and repaired until the leakage is within the specified allowance, without additional cost to the Government.

### 3.2.3 Time for Making Test

Except for joint material setting or where concrete thrust blocks necessitate a 5-day delay, pipelines jointed with rubber gaskets, mechanical or push-on joints, or couplings may be subjected to hydrostatic pressure, inspected, and tested for leakage at any time after partial completion of backfill. Cement-mortar lined pipe may be filled with water as recommended by the manufacturer before being subjected to the pressure test and subsequent leakage test.

### 3.2.4 Concurrent Hydrostatic Tests

The Contractor may elect to conduct the hydrostatic tests using either or both of the following procedures. Regardless of the sequence of tests employed, the results of pressure tests, leakage tests, and disinfection shall be as specified. Replacement, repair or retesting required shall be accomplished by the Contractor at no additional cost to the Government.

- a. Pressure test and leakage test may be conducted concurrently.
- b. Hydrostatic tests and disinfection may be conducted concurrently, using the water treated for disinfection to accomplish the hydrostatic tests. If water is lost when treated for disinfection and air is admitted to the unit being tested, or if any repair procedure results in contamination of the unit, disinfection shall



be reaccomplished.

### 3.3 Bacteriological Disinfection

#### 3.3.1 Bacteriological Disinfection

Before acceptance of potable water operation, each unit of completed waterline shall be disinfected as prescribed by AWWA C651 or as specified herein. After pressure tests have been made, the unit to be disinfected shall be thoroughly flushed with water until all entrained dirt and mud have been removed before introducing the chlorinating material. The chlorinating material shall be either liquid chlorine, calcium hypochlorite, or sodium hypochlorite, conforming to paragraph MISCELLANEOUS ITEMS. The chlorinating material shall provide a dosage of not less than 50 ppm and shall be introduced into the water lines in an approved manner. Polyvinyl Chloride (PVC) pipe lines shall be chlorinated using only the above specified chlorinating material in solution. The agent shall not be introduced into the line in a dry solid state. The treated water shall be retained in the pipe long enough to destroy all non-spore forming bacteria.

Except where a shorter period is approved, the retention time shall be at least 24 hours and shall produce not less than 25 ppm of free chlorine residual throughout the line at the end of the retention period. Valves on the lines being disinfected shall be opened and closed several times during the contact period. The line shall then be flushed with clean water until the residual chlorine is reduced to less than 1.0 ppm. During the flushing period, each fire hydrant on the line shall be opened and closed several times. From several points in the unit, personnel from the Contractor's commercial laboratory shall take at least 3 water samples from different points, approved by the Contracting Officer, in proper sterilized containers and perform a bacterial examination in accordance with state approved methods. The commercial laboratory shall be certified by the state's approving authority for examination of potable water. The disinfection shall be repeated until tests indicate the absence of pollution for at least 2 full days. The unit will not be accepted until satisfactory bacteriological results have been obtained.

### 3.4 CLEANUP

Upon completion of the installation of water lines, and appurtenances, all debris and surplus materials resulting from the work shall be removed.

### 3.5 Satisfactory Installation

The contractor shall submit a Satisfactory Installation statement signed by the principal officer of the contracting firm stating that the installation is satisfactory and in accordance with the contract drawings and specifications, and the manufacturer's prescribed procedures and techniques, upon completion of the project and before final acceptance.

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## SECTION 02531A

## SANITARY SEWERS

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 74	(1998) Cast Iron Soil Pipe and Fittings
ASTM A 123/A 123M	(2000) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM C 14M	(1999) Concrete Sewer, Storm Drain, and Culvert Pipe (Metric)
ASTM C 33	(1999a <sup>1</sup> ) Concrete Aggregates
ASTM C 76M	(2000) Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric)
ASTM C 94/C 94M	(2000) Ready-Mixed Concrete
ASTM C 150	(1999a) Portland Cement
ASTM C 260	(2000) Air-Entraining Admixtures for Concrete
ASTM C 270	(2000) Mortar for Unit Masonry
ASTM C 425	(2000) Compression Joints for Vitrified Clay Pipe and Fittings
ASTM C 443M	(1998) Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets (Metric)
ASTM C 478	(1997) Precast Reinforced Concrete Manhole Sections
ASTM C 478M	(1997) Precast Reinforced Concrete Manhole Sections (Metric)

ASTM C 564	(1997) Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C 700	(2000) Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
ASTM C 828	(1998) Low-Pressure Air Test of Vitrified Clay Pipe Lines
ASTM C 924M	(1998) Concrete Pipe Sewer Lines by Low-Pressure Air Test Method (Metric)
ASTM C 972	(2000) Compression-Recovery of Tape Sealant
ASTM D 412	(1998a) Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension
ASTM D 624	(2000) Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
ASTM D 1784	(1999a) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 2680	(1995a) Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping
ASTM D 2751	(1996a) Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings
ASTM D 2996	(1995) Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D 2997	(1999) Centrifugally Cast "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D 3034	(1998) Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D 3212	(1996a) Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D 3262	(1996) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe
ASTM D 3350	(1999) Polyethylene Plastics Pipe and Fittings Materials

ASTM D 3753	(1999) Glass-Fiber-Reinforced Polyester Manholes
ASTM D 3840	(1999) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Fittings for Nonpressure Applications
ASTM D 4161	(1996) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe Joints Using Flexible Elastomeric Seals
ASTM F 402	(1993; R 1999) Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings
ASTM F 477	(1999) Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 714	(2000) Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
ASTM F 794	(1999) Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
ASTM F 894	(1998a) Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
ASTM F 949	(2000) Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings

## AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C105	(1999) Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C110	(1998) Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (75 mm through 1200 mm), for Water and Other Liquids
AWWA C111	(2000) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115	(1999) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C151	(1996) Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 49	(1994) Hazardous Chemicals Data
NFPA 325-1	(1994) Fire Hazard Properties of Flammable Liquids, Gases, and Volatile Solids
NFPA 704	(1996) Identification of the Fire Hazards of Materials for Emergency Response

UNI-BELL PVC PIPE ASSOCIATION (UBPPA)

UBPPA UNI-B-6	(1990) Recommended Practice for the Low-Pressure Air Testing of Installed Sewer Pipe
UBPPA UNI-B-9	(1990; Addenda 1994) Recommended Performance Specification for Polyvinyl Chloride (PVC) Profile Wall Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter (Nominal Pipe Sizes 4-48 inch)

## 1.2 GENERAL REQUIREMENTS

The construction required herein shall include appurtenant structures and building sewers to points of connection with the building drains 1.5 m outside the building to which the sewer system is to be connected. The Contractor shall replace damaged material and redo unacceptable work at no additional cost to the Government. Excavation and backfilling is specified in Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS. Backfilling shall be accomplished after inspection by the Contracting Officer. Before, during, and after installation, plastic pipe and fittings shall be protected from any environment that would result in damage or deterioration to the material. The Contractor shall have a copy of the manufacturer's instructions available at the construction site at all times and shall follow these instructions unless directed otherwise by the Contracting Officer. Solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install the plastic pipe shall be stored in accordance with the manufacturer's recommendation and shall be discarded if the storage period exceeds the recommended shelf life. Solvents in use shall be discarded when the recommended pot life is exceeded.

## 1.3 MEASUREMENT AND PAYMENT

Measurements and payments will be based on completed work performed in accordance with the drawings, specifications, and the contract payment schedules. No payment will be made under this section for excavation, backfilling, or grading. Payment for such work will be made under Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.

### 1.3.1 Installed Pipe

The length of pipe installed will be measured from center to center of



manholes and from the center of sewer to the end of the service connections without deduction for fittings or diameters of manholes and will be paid for according to the applicable contract unit price per meter for the size of pipe. No extra payment will be made for bends.

#### 1.3.2 Manholes

The depth of manholes will be measured from the top of the cover to the invert of the outlet pipe. Manholes will be paid for according to the applicable contract price each for the depth of manhole indicated in the payment schedule. No extra payment will be made for drop manholes except that the concrete used for encasing the drop connection will be measured and paid for according to the contract unit price per cubic meter of concrete for encasement, and no extra payment will be made for pipe fittings required to make connections to manholes.

#### 1.3.3 Concrete

Concrete used for pipe encasement, cradles, and similar supports, indicated or required for reasons other than faulty construction methods or negligence of the Contractor, will be measured and paid for according to the contract unit price for concrete for encasement and cradles.

#### 1.3.4 Connections to Existing Manholes

Connections to existing manholes will be paid for according to the applicable contract unit price per connection for each required size of pipe, which shall be full compensation for all necessary cutting, shaping, pipe fittings, and concrete, except that concrete required for encasing or cradling pipe outside the manhole will be measured and paid for according to the contract unit price for such concrete.

#### 1.3.5 Wye Branches

Wye branches installed in new sewers will be paid for according to the applicable contract unit price for the size indicated in the payment schedule. This will be in addition to the price per meter of straight pipe.

#### 1.3.6 Connections to Existing Sewers

Connections to existing sewers where new wye branches to cut-ins are required will be paid for according to the contract unit price for such connection. The price will be considered as full compensation for material and labor required for the removal and replacement of the pipe as necessary. Excavation, backfill, and concrete connected with such work will be paid for according to the applicable contract unit prices. Connections of this type made to sewers installed under this contract, if ordered after the sewer has been installed, will be paid for as connection to existing sewers.

#### 1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When

used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

#### SD-07 Certificates

Portland Cement; G, RE.

Certificates of compliance stating the type of cement used in manufacture of concrete pipe, fittings and precast manholes.

Joints; G, RE.

Certificates of compliance stating that the fittings or gaskets used for waste drains or lines designated on the plans as shown are oil resistant.

## PART 2 PRODUCTS

### 2.1 PIPE

Pipe shall conform to the respective specifications and other requirements specified below.

#### 2.1.1 Concrete Pipe

Concrete pipe 600 mm (24 inches) or less in diameter, unless otherwise shown or specified, shall be nonreinforced and conform to ASTM C 14M, Class 2. Concrete pipe greater than 600 mm (24 inches in diameter shall be reinforced and conform to ASTM C 76M, Class II. Pipe less than 900 mm (36 inches) in diameter shall be bell and spigot type. Pipe 900 mm (36 inches) or greater in diameter shall be bell and spigot type, tongue and groove type, or modified tongue and groove type.

#### 2.1.2 Plastic Pipe

Acrylonitrile-butadiene-styrene (ABS) and polyvinyl chloride (PVC) composite sewer piping shall conform to ASTM D 2680. Size 200 mm (8 inch) through 380 mm (15 inch) diameter.

##### 2.1.2.1 ABS Pipe

ASTM D 2751.

##### 2.1.2.2 PVC Pipe

ASTM D 3034, Type PSM with a maximum SDR of 35, Size 380 mm (15 inch) or less in diameter. ASTM F 949 for corrugated sewer pipes with a smooth interior. UBPPA UNI-B-9 and ASTM F 794, Series 46, for ribbed sewer pipe with smooth interior, size 200 mm (8 inch) through 1200 mm (48 inch) diameters. PVC shall be certified by the compounder as meeting the requirements of ASTM D 1784, cell Class 12454B. The pipe stiffness shall be greater than or equal to 735/D for cohesionless material pipe trench backfills.

### 2.1.2.3 High Density Polyethylene Pipe

ASTM F 894, Class 63, size 450 mm (18 inch) through 3000 mm (120 inch). ASTM F 714, size 100 mm (4 inch) through 1200 mm (48 inch). The polyethylene shall be certified by the resin producer as meeting the requirements of ASTM D 3350, cell Class 334433C. The pipe stiffness shall be greater than or equal to  $1170/D$  for cohesionless material pipe trench backfills.

### 2.1.3 Reinforced Plastic Mortar Pipe (RPMP)

Reinforced plastic mortar pipe shall be produced by centrifugal casting and shall have an outside diameter equal to ductile iron pipe dimensions from 450 mm to 1200 mm. The inner surface of the pipe shall have a smooth uniform continuous resin-rich surface liner. The minimum pipe stiffness shall be 248 kPa. RPMP shall be in accordance with ASTM D 3262.

### 2.1.4 Reinforced Thermosetting Resin Pipe (RTRP)

ASTM D 3262.

#### 2.1.4.1 Filament Wound RTRP-I

RTRP-I shall conform to ASTM D 2996, except pipe shall have an outside diameter equal to cast iron outside diameter or standard weight steel pipe.

The pipe shall be suitable for a normal working pressure of 1.03 MPa (150 psi) at 22.8 degrees C (73 degrees F). The inner surface of the pipe shall have a smooth uniform continuous resin-rich surface liner conforming to ASTM D 2996.

#### 2.1.4.2 Centrifugally Cast RTRP-II

RTRP-II shall conform to ASTM D 2997. Pipe shall have an outside diameter equal to standard weight steel pipe.

### 2.1.5 Ductile Iron Pipe

Pipe shall conform to AWWA C151 unless otherwise shown or specified.

### 2.1.6 Cast Iron Soil Pipe

Cast iron soil pipe shall conform to ASTM A 74, Class SV, except where Class XH is indicated. Lines indicated as acid resistant shall be Class XH and contain not less than 12 percent silicon. When installed underground, pipe shall be encased with 1 mm thick polyethylene in accordance with AWWA C105.

### 2.1.7 Clay Pipe

ASTM C 700 Extra strength and acid resistant, where indicated.

## 2.2 REQUIREMENTS FOR FITTINGS

Fittings shall be compatible with the pipe supplied and shall have a

strength not less than that of the pipe. Fittings shall conform to the respective specifications and other requirements specified below.

#### 2.2.1 Fittings for Concrete Pipe

ASTM C 14M for pipe 600 mm (24 inches) or less in diameter. ASTM C 76M for pipe greater than 600 mm (24 inches) in diameter.

#### 2.2.2 Fittings for Plastic Pipe

ABS and PVC composite sewer pipe fittings shall conform to ASTM D 2680.

##### 2.2.2.1 Fittings for ABS Pipe

ASTM D 2751.

##### 2.2.2.2 Fittings for PVC Pipe

ASTM D 3034 for type PSM pipe. ASTM F 949 for corrugated sewer pipe with a smooth interior. UBPPA UNI-B-9 and ASTM F 794, Series 46, for ribbed sewer pipe with smooth interior.

##### 2.2.2.3 Fittings for High Density Polyethylene Pipe

ASTM F 894.

##### 2.2.3 Fittings for RPMP

ASTM D 3840.

##### 2.2.4 Fittings for RTRP

ASTM D 3262.

##### 2.2.5 Fittings for Ductile Iron Pipe

Mechanical fittings shall conform to AWWA C110, rated for 1.03 MPa (150 psi).

Push-on fittings shall conform to AWWA C110 and AWWA C111, rated for 10.3 MPa (150 psi).

##### 2.2.6 Fittings for Cast Iron Soil Pipe

ASTM A 74.

##### 2.2.7 Fittings for Clay Pipe

ASTM C 700 Extra strength and acid resistant.

#### 2.3 JOINTS

Joints installation shall comply with the manufacturer's instructions. Fittings and gaskets utilized for waste drains or industrial waste lines shall be certified by the manufacturer as oil and acid resistant.

### 2.3.1 Concrete Pipe Jointing

Joints and gaskets shall conform to ASTM C 443M.

### 2.3.2 Plastic Pipe Jointing

Flexible plastic pipe (PVC or high density polyethylene pipe) gasketed joints shall conform to ASTM D 3212.

#### 2.3.2.1 ABS Pipe Jointing

ASTM D 2751, solvent weld or bell and spigot O-ring joint, size 300 mm (12 inches) or less in diameter, dimensions and tolerances in accordance with Table 2 of ASTM D 2751.

#### 2.3.2.2 High Density Polyethylene Pipe Jointing

Rubber gasket joints shall conform to ASTM C 443M.

### 2.3.3 RPMP Jointing

Joints shall be bell and spigot gasket coupling utilizing an elastomeric gasket in accordance with ASTM D 4161 and ASTM F 477.

### 2.3.4 RTRP Jointing

Joints shall be bell and spigot type utilizing an elastomeric gasket in accordance with ASTM F 477.

### 2.3.5 Ductile Iron Pipe Jointing

Push-on joints shall conform to AWWA C111. Mechanical joints shall conform to AWWA C111 as modified by AWWA C151. Flanged joints shall conform to AWWA C115.

### 2.3.6 Cast Iron Soil Pipe Jointing

Rubber gaskets for compression joints shall conform to ASTM C 564. Packing material for caulked joints shall be twisted jute or oakum, tarred type, or asphalt-saturated cellulose-fiber. Joints for acid resisting cast iron soil pipe shall be made with acid resistant non-asbestos packing. The packing shall not contain material which would affect adhesion of the joint sealing material to the pipe. Lead shall be suitable for caulking of joints.

### 2.3.7 Clay Pipe Jointing

Compression joints shall conform to ASTM C 425.

## 2.4 BRANCH CONNECTIONS

Branch connections shall be made by use of regular fittings or solvent cemented saddles as approved. Saddles for ABS and PVC composite pipe shall conform to Figure 2 of ASTM D 2680; saddles for ABS pipe shall comply with

Table 3 of ASTM D 2751; and saddles for PVC pipe shall conform to Table 4 of ASTM D 3034.

## 2.5 FRAMES AND COVERS

Frames and covers shall be cast iron, ductile iron or reinforced concrete. Cast iron frames and covers shall be as indicated or shall be of type suitable for the application, circular, without vent holes. The frames and covers shall have a combined weight of not less than 181.4 kg (400 pounds).

Reinforced concrete frames and covers shall be as indicated or shall conform to ASTM C 478 or ASTM C 478M. The word "Sewer" shall be stamped or cast into covers so that it is plainly visible.

## 2.6 STEEL LADDER

A steel ladder shall be provided where the depth of a manhole exceeds 3.6 m (12 feet). The ladder shall not be less than 406 mm (16 inches) in width, with 19 mm (3/4 inch) diameter rungs spaced 305 mm (12 inches) apart. The two stringers shall be a minimum 10 mm (3/8 inch) thick and 51 mm (2 inch) wide. Ladders and inserts shall be galvanized after fabrication in conformance with ASTM A 123/A 123M.

## 2.7 CEMENT MORTAR

Cement mortar shall conform to ASTM C 270, Type M with Type II cement.

### 2.7.1 Portland Cement

Portland cement shall conform to ASTM C 150, Type II for concrete used in concrete pipe, concrete pipe fittings, and manholes and type optional with the Contractor for cement used in concrete cradle, concrete encasement, and thrust blocking. Air-entraining admixture conforming to ASTM C 260 shall be used with Type V cement. Where aggregates are alkali reactive, as determined by Appendix XI of ASTM C 33, a cement containing less than 0.60 percent alkalies shall be used.

### 2.7.2 Portland Cement Concrete

Portland cement concrete shall conform to ASTM C 94/C 94M, compressive strength of 28 MPa at 28 days, except for concrete cradle and encasement or concrete blocks for manholes. Concrete used for cradle and encasement shall have a compressive strength of 17 MPa minimum at 28 days. Concrete in place shall be protected from freezing and moisture loss for 7 days.

## 2.8 STRUCTURES

### 2.8.1 Precast Reinforced Concrete Manhole Sections

Precast reinforced concrete manhole sections shall conform to ASTM C 478, except that portland cement shall be as specified herein. Joints shall be cement mortar, an approved mastic, rubber gaskets, a combination of these types; or the use of external preformed rubber joint seals and extruded rolls of rubber with mastic adhesive on one side.

### 2.8.2 Glass-Fiber-Reinforced Polyester Manholes

Glass-fiber-reinforced polyester manholes shall conform to ASTM D 3753.

## PART 3 EXECUTION

### 3.1 INSTALLATION

#### 3.1.1 Adjacent Facilities

##### 3.1.1.1 Water Lines

Where the location of the sewer is not clearly defined by dimensions on the drawings, the sewer shall not be closer horizontally than 3 m to a water-supply main or service line, except that where the bottom of the water pipe will be at least 300 mm above the top of the sewer pipe, the horizontal spacing may be a minimum of 2 m. Where gravity-flow sewers cross above water lines, the sewer pipe for a distance of 3 m on each side of the crossing shall be fully encased in concrete or shall be acceptable pressure pipe with no joint closer horizontally than 1 m to the crossing. The thickness of the concrete encasement including that at the pipe joints shall be not less than 100 mm.

##### 3.1.1.2 Under Reinforced Concrete Channel Inverts

Water pipe shall be encased in a sleeve of rigid conduit for the lengths shown. Sleeves under reinforced concrete channel inverts shall be in accordance with the drawings. Where sleeves are required, in all other cases, the pipe sleeve shall be as specified for storm drains in Section 02630 STORM-DRAINAGE SYSTEM. A minimum clearance of at least 50 mm between the inner wall of the sleeve and the maximum outside diameter of the sleeved pipe and joints shall be provided. Sand bedding shall be provided for the water pipe through the sleeve. Sleeves of ferrous material shall be provided with the corrosion protection as required for the conditions encountered at the site of installation.

##### 3.1.1.3 Structural Foundations

Where sewer pipe is to be installed within 1 m of an existing or proposed building or structural foundation such as a retaining wall, control tower footing, water tank footing, or any similar structure, the sewer pipe shall be sleeved as specified above. Contractor shall ensure there is no damage to these structures, and no settlement or movement of foundations or footing.

#### 3.1.2 Pipe Laying

- a. Pipe shall be protected during handling against impact shocks and free fall; the pipe interior shall be free of extraneous material.
- b. Pipe laying shall proceed upgrade with the spigot ends of bell-and-spigot pipe and tongue ends of tongue-and-groove pipe pointing in the direction of the flow. Each pipe shall be laid accurately to the line and grade shown on the drawings. Pipe

shall be laid and centered so that the sewer has a uniform invert. As the work progresses, the interior of the sewer shall be cleared of all superfluous materials.

- c. Before making pipe joints, all surfaces of the portions of the pipe to be joined shall be clean and dry. Lubricants, primers, and adhesives shall be used as recommended by the pipe manufacturer. The joints shall then be placed, fitted, joined, and adjusted to obtain the degree of water tightness required.
- d. ABS composite pipe ends with exposed truss and filler material shall be coated with solvent weld material before making the joint to prevent water or air passage at the joint between the inner and outer wall of the pipe.
- e. Installations of solvent weld joint pipe, using ABS or PVC pipe and fittings shall be in accordance with ASTM F 402. The Contractor shall ensure adequate trench ventilation and protection for workers installing the pipe.

#### 3.1.2.1 Caulked Joints

The packing material shall be well packed into the annular space to prevent the entrance of lead into the pipe. The remainder of the space shall be filled with molten lead that is hot enough to show a rapid change in color when stirred. Scum shall be removed before pouring. The lead shall be caulked to form a tight joint without overstraining the bell and shall have a minimum depth of 25 mm after caulking.

#### 3.1.2.2 Trenches

Trenches shall be kept free of water and as dry as possible during bedding, laying, and jointing and for as long a period as required. When work is not in progress, open ends of pipe and fittings shall be satisfactorily closed so that no trench water or other material will enter the pipe or fittings.

#### 3.1.2.3 Backfill

As soon as possible after the joint is made, sufficient backfill material shall be placed along the pipe to prevent pipe movement off line or grade. Plastic pipe shall be completely covered to prevent damage from ultraviolet light.

#### 3.1.2.4 Width of Trench

If the maximum width of the trench at the top of the pipe, as specified in Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS, is exceeded for any reason other than by direction, the Contractor shall install, at no additional cost to the Government, concrete cradling, pipe encasement, or other bedding required to support the added load of the backfill.

#### 3.1.2.5 Jointing



Joints between different pipe materials shall be made as specified, using approved jointing materials.

#### 3.1.2.6 Handling and Storage

Pipe, fittings and joint material shall be handled and stored in accordance with the manufacturer's recommendations. Storage facilities for plastic pipe, fittings, joint materials and solvents shall be classified and marked in accordance with NFPA 704, with classification as indicated in NFPA 49 and NFPA 325-1.

#### 3.1.3 Leakage Tests

Lines shall be tested for leakage by low pressure air testing, infiltration tests or exfiltration tests, as appropriate. Low pressure air testing for vitrified clay pipes shall be as prescribed in ASTM C 828. Low pressure air testing for concrete pipes shall be as prescribed in ASTM C 828. Low pressure air testing for PVC pipe shall be as prescribed in UBPPA UNI-B-6. Low pressure air testing procedures for other pipe materials shall use the pressures and testing times prescribed in ASTM C 828 and ASTM C 924M, after consultation with the pipe manufacturer. Prior to infiltration or exfiltration tests, the trench shall be backfilled up to at least the lower half of the pipe. If required, sufficient additional backfill shall be placed to prevent pipe movement during testing, leaving the joints uncovered to permit inspection. Visible leaks encountered shall be corrected regardless of leakage test results. When the water table is 600 mm or more above the top of the pipe at the upper end of the pipeline section to be tested, infiltration shall be measured using a suitable weir or other device acceptable to the Contracting Officer. When the Contracting Officer determines that infiltration cannot be properly tested, an exfiltration test shall be made by filling the line to be tested with water so that a head of at least 600 mm is provided above both the water table and the top of the pipe at the upper end of the pipeline to be tested. The filled line shall be allowed to stand until the pipe has reached its maximum absorption, but not less than 4 hours. After absorption, the head shall be re-established. The amount of water required to maintain this water level during a 2-hour test period shall be measured. Leakage as measured by either the infiltration test or exfiltration test shall not exceed 94 L per 1 mm diameter per km of pipeline per day. When leakage exceeds the maximum amount specified, satisfactory correction shall be made and retesting accomplished. Testing, correction, and retesting shall be made at no additional cost to the Government.

#### 3.1.4 Test for Deflection

When flexible pipe is used, a deflection test shall be made on the entire length of the installed pipeline not less than 30 days after the completion of all work including the leakage test, backfill, and placement of any fill, grading, paving, concrete, or superimposed loads. Deflection shall be determined by use of a deflection device or by use of a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft. The ball, cylinder, or circular sections shall have a diameter, or minor diameter as applicable, of 92.5 percent of the inside

diameter of the pipe, but 95 percent for RPMP and RTRP. A tolerance of plus 0.5 percent will be permitted. The ball, cylinder, or circular sections shall be of a homogeneous material throughout, shall have a density greater than 1.0 as related to water at 4.0 degrees C (39.2 degrees F), and shall have a surface brinell hardness of not less than 150. The device shall be center bored and through bolted with a 6 mm (1/4 inch) minimum diameter steel shaft having a yield strength of 480 MPa (70,000 psi) or more, with eyes at each end for attaching pulling cables. The eye shall be suitably backed with flange or heavy washer; a pull exerted on the opposite end of the shaft shall produce compression throughout the remote end of the ball, cylinder or circular section. Circular sections shall be spaced so that the distance from the external faces of the front and back sections shall equal or exceed the diameter of the circular section. Failure of the ball, cylinder, or circular section to pass freely through a pipe run, either by being pulled through or by being flushed through with water, shall be cause for rejection of that run. When a deflection device is used for the test in lieu of the ball, cylinder, or circular sections described, such device shall be approved prior to use. The device shall be sensitive to 1.0 percent of the diameter of the pipe being measured and shall be accurate to 1.0 percent of the indicated dimension. Installed pipe showing deflections greater than 7.5 percent of the normal diameter of the pipe, or 5 percent for RTRP and RPMP, shall be retested by a run from the opposite direction. If the retest also fails, the suspect pipe shall be replaced at no cost to the Government.

### 3.2 CONCRETE CRADLE AND ENCASEMENT

The pipe shall be supported on a concrete cradle, or encased in concrete where indicated or directed.

### 3.3 INSTALLATION OF WYE BRANCHES

Wye branches shall be installed where sewer connections are indicated or where directed. Cutting into piping for connections shall not be done except in special approved cases. When the connecting pipe cannot be adequately supported on undisturbed earth or tamped backfill, the pipe shall be encased in concrete backfill or supported on a concrete cradle as directed. Concrete required because of conditions resulting from faulty construction methods or negligence by the Contractor shall be installed at no additional cost to the Government. The installation of wye branches in an existing sewer shall be made by a method which does not damage the integrity of the existing sewer. One acceptable method consists of removing one pipe section, breaking off the upper half of the bell of the next lower section and half of the running bell of wye section. After placing the new section, it shall be rotated so that the broken half of the bell will be at the bottom. The two joints shall then be made with joint packing and cement mortar.

### 3.4 MANHOLE DETAILS

#### 3.4.1 General Requirements

Manholes shall be constructed of glass-fiber-reinforced polyester, prefabricated plastic, concrete, or precast concrete manhole sections. The

invert channels shall be smooth and semicircular in shape conforming to the inside of the adjacent sewer section. Changes in direction of flow shall be made with a smooth curve of as large a radius as the size of the manhole will permit. Changes in size and grade of the channels shall be made gradually and evenly. The invert channels shall be formed directly in the concrete of the manhole base, or shall be built up with brick and mortar, or shall be half tile laid in concrete, or shall be constructed by laying full section sewer pipe through the manhole and breaking out the top half after the surrounding concrete has hardened. Pipe connections shall be made to manhole using water stops, standard O-ring joints, special manhole coupling, or shall be made in accordance with the manufacturer's recommendation. The Contractor's proposed method of connection, list of materials selected, and specials required, shall be approved prior to installation. The floor of the manhole outside the channels shall be smooth and shall slope toward the channels not less than 100 mm per meter nor more than 200 mm per meter. Free drop inside the manholes shall not exceed 500 mm, measured from the invert of the inlet pipe to the top of the floor of the manhole outside the channels; drop manholes shall be constructed whenever the free drop would otherwise be greater than 500 mm.

#### 3.4.2 Steel Ladder Anchorage

Ladder shall be adequately anchored to the wall by means of steel inserts spaced not more than 1850 mm apart vertically, and shall be installed to provide at least 150 mm of space between the wall and the rungs. The wall along the line of the ladder shall be vertical for its entire length.

#### 3.4.3 Jointing, Plastering and Sealing

Mortar joints shall be completely filled and shall be smooth and free from surplus mortar on the inside of the manhole. Mortar and mastic joints between precast rings shall be full-bedded in jointing compound and shall be smoothed to a uniform surface on both the interior and exterior of the manhole. Installation of rubber gasket joints between precast rings shall be in accordance with the recommendations of the manufacturer. Precast rings may also be sealed by the use of extruded rolls of rubber with mastic adhesive on one side.

#### 3.4.4 Setting of Frames and Covers

Unless otherwise indicated, tops of frames and covers shall be set flush with finished grade in paved areas or 50 mm higher than finished grade in unpaved areas. Frame and cover assemblies shall be sealed to manhole sections using external preformed rubber joint seals that meet the requirements of ASTM D 412 and ASTM D 624, or other methods specified in paragraph Jointing, Plastering and Sealing, unless otherwise specified.

#### 3.4.5 External Preformed Rubber Joint Seals

External preformed rubber joint seals and extruded rolls of rubber with mastic adhesive shall meet the requirements of ASTM D 412 and ASTM C 972 to ensure conformance with paragraph Leakage Tests. The seal shall be multi-section with neoprene rubber top section and all lower sections made of Ethylene Propylene Di Monomer (EPDM) rubber with a minimum thickness of

1.5 mm. Each unit shall consist of a top and a bottom section and shall have mastic on the bottom of the bottom section and mastic on the top and bottom of the top section. The mastic shall be non-hardening butyl rubber sealant and shall seal to the cone/top slab of the manhole/catch basin and over the lip of the casting. One unit shall seal a casting and up to six, 50 mm adjusting rings. The bottom section shall be 305 mm in height. A 152 mm high top section will cover up to two, 50 mm adjusting rings. A 305 mm high bottom section will cover up to six, 50 mm adjusting rings. Extension sections shall cover up to two more adjusting rings. Each extension shall overlap the bottom section by 50 mm and shall be overlapped by the top section by 50 mm.

### 3.5 CONNECTING TO EXISTING MANHOLES

Pipe connections to existing manholes shall be made so that finish work will conform as nearly as practicable to the applicable requirements specified for new manholes, including all necessary concrete work, cutting, and shaping. The connection shall be centered on the manhole. Holes for the new pipe shall be of sufficient diameter to allow packing cement mortar around the entire periphery of the pipe but no larger than 1.5 times the diameter of the pipe. Cutting the manhole shall be done in a manner that will cause the least damage to the walls.

### 3.6 BUILDING CONNECTIONS

Building connections shall include the lines to and connection with the building waste drainage piping at a point approximately 1.5 m outside the building, unless otherwise indicated. Where building drain piping is not installed, the Contractor shall terminate the building connections approximately 1.5 m from the site of the building at a point and in a manner designated.

### 3.7 CLEANOUTS AND OTHER APPURTENANCES

Cleanouts and other appurtenances shall be installed where shown on the drawings or as directed by the Contracting Officer, and shall conform to the detail of the drawings.

-- End of Section --

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## SECTION 02630

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## SECTION 02630

## STORM-DRAINAGE SYSTEM

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## ACI INTERNATIONAL (ACI)

ACI 346/346R	(1990) Standard Specification for Cast-in-Place Nonreinforced Concrete Pipe and Recommendations
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AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS  
(AASHTO)

AASHTO HB-16	(1996) Standard Specifications for Highway Bridges
AASHTO M 167	(1994) Corrugated Steel Structural Plate, Zinc Coated, for Field Bolted Pipe
AASHTO M 190	(1995) Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches
AASHTO M 198	(1998) Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets
AASHTO M 219	(1992; R 1995) Aluminum Alloy Structural Plate for Field Bolted Conduits
AASHTO M 243	(1996) Field Applied Coating of Corrugated Metal Structural Plate for Pipe, Pipe-Arches, and Arches
AASHTO M 294	(1998) Corrugated Polyethylene Pipe, 300- to 1200- mm Diameter
AASHTO MP7	(1997) Corrugated Polyethylene Pipe, 1350 and 1500 mm Diameter

AMERICAN RAILWAY ENGINEERING & MAINTENANCE-OF-WAY ASSOCIATION  
(AREMA)



AREMA Manual (1999) Manual for Railway Engineering (4 Vol.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 48M	(1994el) Gray Iron Castings (Metric)
ASTM A 123/A 123M	(2000) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 536	(1999el) Ductile Iron Castings
ASTM A 716	(1995) Ductile Iron Culvert Pipe
ASTM A 742/A 742M	(1998) Steel Sheet, Metallic Coated and Polymer Precoated for Corrugated Steel Pipe
ASTM A 760/A 760M	(1997) Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
ASTM A 762/A 762M	(1998) Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains
ASTM A 798/A 798M	(1997a) Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications
ASTM A 807	(1997) Installing Corrugated Steel Structural Plate Pipe for Sewers and Other Applications
ASTM A 849	(1997) Post-Applied Coatings, Pavings, and Linings for Corrugated Steel Sewer and Drainage Pipe
ASTM A 929/A 929M	(1997) Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe
ASTM B 26/B 26M	(1999) Aluminum-Alloy Sand Castings
ASTM B 745/B 745M	(1997) Corrugated Aluminum Pipe for Sewers and Drains
ASTM C 12	(1998el) Installing Vitrified Clay Pipe Lines
ASTM C 14M	(1999) Concrete Sewer, Storm Drain, and Culvert Pipe (Metric)
ASTM C 32	(1999el) Sewer and Manhole Brick (Made from Clay or Shale)
ASTM C 55	(1999) Concrete Brick

ASTM C 62	(1997a) Building Brick (Solid Masonry Units Made from Clay or Shale)
ASTM C 76M	(2000) Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric)
ASTM C 139	(1999) Concrete Masonry Units for Construction of Catch Basins and Manholes
ASTM C 231	(1997e1) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 270	(2000) Mortar for Unit Masonry
ASTM C 425	(2000) Compression Joints for Vitrified Clay Pipe and Fittings
ASTM C 443	(1998) Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
ASTM C 443M	(1998) Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets (Metric)
ASTM C 478M	(1997) Precast Reinforced Concrete Manhole Sections (Metric)
ASTM C 506M	(1999) Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe (Metric)
ASTM C 507M	(1999) Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe (Metric)
ASTM C 655	(2000) Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe
ASTM C 700	(2000) Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
ASTM C 789	(1998) Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers
ASTM C 828	(1998) Low-Pressure Air Test of Vitrified Clay Pipe Lines
ASTM C 850	(1998) Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers with Less Than 2 Ft. of Cover Subjected to Highway Loadings
ASTM C 877M	(1994) External Sealing Bands for

	Noncircular Concrete Sewer, Storm Drain, and Culvert Pipe (Metric)
ASTM C 923	(1998) Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Materials
ASTM C 924M	(1998) Concrete Pipe Sewer Lines by Low-Pressure Air Test Method (Metric)
ASTM C 1103M	(1994) Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines (Metric)
ASTM D 1056	(1998) Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D 1171	(1994) Rubber Deterioration - Surface Ozone Cracking Outdoors or Chamber (Triangular Specimens)
ASTM D 1557	(2000) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu.m.))
ASTM D 1751	(1999) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(1984; R 1996el) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D 1784	(1999a) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 2167	(1994) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2321	(1989; R 1995) Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D 2922	(1996el) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(1988; R 1996el) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow

	Depth)
ASTM D 3034	(1998) Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D 3212	(1996a) Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D 3350	(1999) Polyethylene Plastics Pipe and Fittings Materials
ASTM F 477	(1999) Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 679	(1995) Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
ASTM F 714	(2000) Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
ASTM F 794	(1999) Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
ASTM F 894	(1998a) Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
ASTM F 949	(2000) Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings
ASTM F 1417	(1992; R 1998) Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air

## 1.2 MEASUREMENT AND PAYMENT

### 1.2.1 Pipe Culverts and Storm Drains

The length of pipe installed will be measured along the centerlines of the pipe from end to end of pipe without deductions for diameter of manholes. Pipe will be paid for at the contract unit price for the number of linear meters of culverts or storm drains placed in the accepted work.

### 1.2.2 Manholes and Inlets

The quantity of manholes and inlets will be measured as the total number of manholes and inlets of the various types of construction, complete with frames and gratings or covers and, where indicated, with fixed side-rail ladders, constructed to the depth of 7 meters, in the accepted work. The depth of manholes and inlets will be measured from the top of grating or cover to invert of outlet pipe. Manholes and inlets constructed to depths greater than the depth specified above will be paid for as units at the

contract unit price for manholes and inlets, plus an additional amount per linear meter for the measured depth beyond a depth of 7 meters.

#### 1.2.3 Walls and Headwalls

Walls and headwalls will be measured by the number of cubic meters of reinforced concrete, plain concrete, or masonry used in the construction of the walls and headwalls. Wall and headwalls will be paid for at the contract unit price for the number of walls and headwalls constructed in the completed work.

#### 1.2.4 Flared End Sections

Flared end sections will be measured by the unit. Flared end sections will be paid for at the contract unit price for the various sizes in the accepted work.

#### 1.2.5 Sheeting and Bracing

Payment will be made for that sheeting and bracing ordered to be left in place, based on the number of square meters of sheeting and bracing remaining below the surface of the ground.

#### 1.2.6 Excavation, Rock and/or Cemented Materials

Payment will be made for the number of cubic meters of material acceptably excavated, as specified and defined in paragraph EXCAVATION in Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS measured in the original position, and computed by allowing actual width of rock excavation with the following limitations: maximum rock excavation width, 750 mm for pipe of 300 mm or less nominal diameter; maximum rock excavation width, 400 mm greater than outside diameter of pipe of more than 300 mm nominal diameter. Measurement will include authorized overdepth excavation. Payment will also include all necessary drilling and blasting, and all incidentals necessary for satisfactory excavation and disposal of authorized rock excavation. No separate payment will be made for backfill material required to replace rock excavation; this cost shall be included in the Contractor's unit price bid per cubic meter for rock excavation. In rock excavation for manholes and other appurtenances, 300 mm will be allowed outside the wall lines of the structures.

#### 1.2.7 Backfill Replacing Unstable Material

Payment will be made for the number of cubic meters of select granular material required to replace unstable material for foundations under pipes or drainage structures, which will constitute full compensation for this backfill material, including removal and disposal of unstable material and all excavating, hauling, placing, compacting, and all incidentals necessary to complete the construction of the foundation satisfactorily.

#### 1.2.8 Pipe Placed by Jacking

Payment will be made for the number of linear meters of jacked pipe accepted in the completed work measured along the centerline of the pipe in

place.

### 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

#### SD-03 Product Data

Placing Pipe; G, RE.

Printed copies of the manufacturer's recommendations for installation procedures of the material being placed, prior to installation.

#### SD-04 Samples

Pipe for Culverts and Storm Drains; G, RE.

Samples of the following materials, before work is started: Concrete Pipe; Horizontal or Vertical Elliptical pipe; clay pipe; Reinforced Concrete Pipe; nonreinforced pipe; cast-in-place pipe/conduit; PVC/PE Pipe; Ductile Iron Pipe; steel pipe.

#### SD-07 Certificates

Resin Certification; G, RE.

Pipeline Testing; G, RE.

Hydrostatic Test on Watertight Joints; G, RE.

Determination of Density; G, RE.

Frame and Cover for Gratings; G, RE.

Certified copies of test reports demonstrating conformance to applicable pipe specifications, before pipe is installed. Certification on the ability of frame and cover or gratings to carry the imposed live load.

### 1.4 DELIVERY, STORAGE, AND HANDLING

#### 1.4.1 Delivery and Storage

Materials delivered to site shall be inspected for damage, unloaded, and stored with a minimum of handling. Materials shall not be stored directly on the ground. The inside of pipes and fittings shall be kept free of dirt and debris. Before, during, and after installation, plastic pipe and fittings shall be protected from any environment that would result in damage or deterioration to the material. The Contractor shall have a copy of the manufacturer's instructions available at the construction site at all times and shall follow these instructions unless directed otherwise by

the Contracting Officer. Solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install plastic pipe shall be stored in accordance with the manufacturer's recommendations and shall be discarded if the storage period exceeds the recommended shelf life. Solvents in use shall be discarded when the recommended pot life is exceeded.

#### 1.4.2 Handling

Materials shall be handled in a manner that ensures delivery to the trench in sound, undamaged condition. Pipe shall be carried to the trench, not dragged.

### PART 2 PRODUCTS

#### 2.1 PIPE FOR CULVERTS AND STORM DRAINS

Pipe for culverts and storm drains shall be of the sizes indicated and shall conform to the requirements specified.

##### 2.1.1 Concrete Pipe

ASTM C 76M, Class II, or ASTM C 655, D-Load.

##### 2.1.1.1 Reinforced Arch Culvert and Storm Drainpipe

ASTM C 506M, Class A-III.

##### 2.1.1.2 Reinforced Elliptical Culvert and Storm Drainpipe

ASTM C 507M. Horizontal elliptical pipe shall be Class HE-II. Vertical elliptical pipe shall be Class VE-II.

##### 2.1.1.3 Nonreinforced Pipe

ASTM C 14M, Class 2.

##### 2.1.1.4 Cast-In-Place Nonreinforced Conduit

ACI 346/346R, except that testing shall be the responsibility of and at the expense of the Contractor. In the case of other conflicts between ACI 346/346R and project specifications, requirements of ACI 346/346R shall govern.

##### 2.1.2 Clay Pipe

Standard or extra strength, as indicated, conforming to ASTM C 700.

##### 2.1.3 Corrugated Steel Pipe

ASTM A 760/A 760M, zinc or aluminum (Type 2) coated pipe of either:

- a. Type II pipe with annular 68 by 13 mm corrugations.

- b. Type IIR pipe with helical 19 by 19 by 190 mm corrugations.

#### 2.1.3.1 Fully Bituminous Coated

AASHTO M 190 Type A and ASTM A 760/A 760M zinc or aluminum (Type 2) coated pipe of either:

- a. Type II pipe with annular 68 by 13 mm corrugations.
- b. Type IIR pipe with helical 19 by 19 by 190 mm corrugations.

#### 2.1.3.2 Half Bituminous Coated, Part Paved

AASHTO M 190 Type B and ASTM A 760/A 760M zinc or aluminum (Type 2) coated Type II pipe with annular 68 by 13 mm corrugations.

#### 2.1.3.3 Fully Bituminous Coated, Part Paved

AASHTO M 190 Type C and ASTM A 760/A 760M zinc or aluminum (Type 2) coated Type II pipe with annular 68 by 13 mm corrugations.

#### 2.1.3.4 Fully Bituminous Coated, Fully Paved

AASHTO M 190 Type D and ASTM A 760/A 760M zinc or aluminum (Type 2) coated Type II pipe with annular 68 by 13 mm corrugations.

#### 2.1.3.5 Concrete-Lined

ASTM A 760/A 760M zinc coated Type I corrugated steel pipe with annular 68 by 13 mm corrugations and a concrete lining in accordance with ASTM A 849.

#### 2.1.3.6 Polymer Precoated

ASTM A 762/A 762M corrugated steel pipe fabricated from ASTM A 742/A 742M Grade 250/250 polymer precoated sheet of either:

- a. Type II pipe with annular 68 by 13 mm corrugations.
- b. Type IIR pipe with helical 19 by 19 by 190 mm corrugations.

#### 2.1.3.7 Polymer Precoated, Part Paved

ASTM A 762/A 762M Type II corrugated steel pipe and AASHTO M 190 Type B (modified), paved invert only, fabricated from ASTM A 742/A 742M Grade 250/250 polymer precoated sheet with annular 68 by 13 mm corrugations.

#### 2.1.3.8 Polymer Precoated, Fully Paved

ASTM A 762/A 762M Type II corrugated steel pipe and AASHTO M 190 Type D (modified), fully paved only, fabricated from ASTM A 742/A 742M Grade 250/250 polymer precoated sheet with annular 68 by 13 mm corrugations.

#### 2.1.4 Corrugated Aluminum Alloy Pipe



ASTM B 745/B 745M corrugated aluminum alloy pipe of either:

- a. Type II pipe with annular corrugations.
- b. Type IIR pipe with helical corrugations.

#### 2.1.4.1 Aluminum Fully Bituminous Coated

AASHTO M 190 Type A and ASTM B 745/B 745M corrugated aluminum alloy pipe of either:

- a. Type II pipe with annular corrugations.
- b. Type IIR pipe with helical corrugations.

#### 2.1.4.2 Aluminum Fully Bituminous Coated, Part Paved

AASHTO M 190 Type C and ASTM B 745/B 745M corrugated aluminum alloy pipe of either:

- a. Type II pipe with annular corrugations.
- b. Type IIR pipe with helical corrugations.

#### 2.1.5 Structural Plate, Steel Pipe, Pipe Arches and Arches

Assembled with galvanized steel nuts and bolts, from galvanized corrugated steel plates conforming to AASHTO M 167. Pipe coating, when required, shall conform to the requirements of AASHTO M 190 Type A. Thickness of plates shall be as indicated.

#### 2.1.6 Structural Plate, Aluminum Pipe, Pipe Arches and Arches

Assembled with either aluminum alloy, aluminum coated steel, stainless steel or zinc coated steel nuts and bolts. Nuts and bolts, and aluminum alloy plates shall conform to AASHTO M 219. Pipe coating, when required, shall conform to the requirements of AASHTO M 190, Type A. Thickness of plates shall be as indicated.

#### 2.1.7 Ductile Iron Culvert Pipe

ASTM A 716.

#### 2.1.8 PVC Pipe

The pipe manufacturer's resin certification, indicating the cell classification of PVC used to manufacture the pipe, shall be submitted prior to installation of the pipe.

##### 2.1.8.1 Type PSM PVC Pipe

ASTM D 3034, Type PSM, maximum SDR 35, produced from PVC certified by the compounder as meeting the requirements of ASTM D 1784, minimum cell class

12454-B.

#### 2.1.1.8.2 Profile PVC Pipe

ASTM F 794, Series 46, produced from PVC certified by the compounder as meeting the requirements of ASTM D 1784, minimum cell class 12454-B.

#### 2.1.1.8.3 Smooth Wall PVC Pipe

ASTM F 679 produced from PVC certified by the compounder as meeting the requirements of ASTM D 1784, minimum cell class 12454-B.

#### 2.1.1.8.4 Corrugated PVC Pipe

ASTM F 949 produced from PVC certified by the compounder as meeting the requirements of ASTM D 1784, minimum cell class 12454-B.

#### 2.1.1.9 PE Pipe

The pipe manufacturer's resin certification indicating the cell classification of PE used to manufacture the pipe shall be submitted prior to installation of the pipe. The minimum cell classification for polyethylene plastic shall apply to each of the seven primary properties of the cell classification limits in accordance with ASTM D 3350.

##### 2.1.1.9.1 Smooth Wall PE Pipe

ASTM F 714, maximum DR of 21 for pipes 80 to 600 mm in diameter and maximum DR of 26 for pipes 650 to 1200 mm in diameter. Pipe shall be produced from PE certified by the resin producer as meeting the requirements of ASTM D 3350, minimum cell class 335434C.

##### 2.1.1.9.2 Corrugated PE Pipe

AASHTO M 294, Type S or D, for pipes 300 to 1200 mm and AASHTO MP7, Type S or D, for pipes 1350 to 1500 mm produced from PE certified by the resin producer as meeting the requirements of ASTM D 3350, minimum cell class in accordance with AASHTO M 294. Pipe walls shall have the following properties:

Nominal Size (mm)	Minimum Wall Area (square mm/m)	Minimum Moment of Inertia of Wall Section (mm to the 4th/mm)
300	3200	390
375	4000	870
450	4900	1020
600	6600	1900
750	8300	2670
900	9500	3640
1050	9900	8900
1200	10900	8900

Nominal Size (mm)	Minimum Wall Area (square mm/m)	Minimum Moment of Inertia of Wall Section (mm to the 4th/mm)
1350	12000	13110
1500	13650	13110

#### 2.1.9.3 Profile Wall PE Pipe

ASTM F 894, RSC 160, produced from PE certified by the resin producer as meeting the requirements of ASTM D 3350, minimum cell class 334433C. Pipe walls shall have the following properties:

Nominal Size (mm)	Minimum Wall Area (square mm/m)	Minimum Moment Of Inertia of Wall Section (mm to the 4th/mm)	
		Cell Class 334433C	Cell Class 335434C
450	6300	850	620
525	8800	1150	840
600	9900	1330	970
675	12500	2050	1490
750	12500	2050	1490
825	14800	2640	2160
900	17100	3310	2700
1050	16500	4540	3720
1200	18700	5540	4540

## 2.2 DRAINAGE STRUCTURES

### 2.2.1 Flared End Sections

Sections shall be of a standard design fabricated from zinc coated steel sheets meeting requirements of ASTM A 929/A 929M.

### 2.2.2 Precast Reinforced Concrete Box

For highway loadings with 600 mm of cover or more or subjected to dead load only, ASTM C 789; for less than 600 mm of cover subjected to highway loading, ASTM C 850.

## 2.3 MISCELLANEOUS MATERIALS

### 2.3.1 Concrete

Unless otherwise specified, concrete and reinforced concrete shall conform

to the requirements for 25 MPa concrete under Section 03301 CAST-IN-PLACE STRUCTURAL CONCRETE. The concrete mixture shall have air content by volume of concrete, based on measurements made immediately after discharge from the mixer, of 5 to 7 percent when maximum size of coarse aggregate exceeds 37.5 mm. Air content shall be determined in accordance with ASTM C 231. The concrete covering over steel reinforcing shall not be less than 25 mm thick for covers and not less than 40 mm thick for walls and flooring. Concrete covering deposited directly against the ground shall have a thickness of at least 75 mm between steel and ground. Expansion-joint filler material shall conform to ASTM D 1751, or ASTM D 1752, or shall be resin-impregnated fiberboard conforming to the physical requirements of ASTM D 1752.

#### 2.3.2 Mortar

Mortar for pipe joints, connections to other drainage structures, and brick or block construction shall conform to ASTM C 270, Type M, except that the maximum placement time shall be 1/2 hour. The quantity of water in the mixture shall be sufficient to produce a stiff workable mortar. Water shall be clean and free of harmful acids, alkalies, and organic impurities.

The mortar shall be used within 30 minutes after the ingredients are mixed with water. The inside of the joint shall be wiped clean and finished smooth. The mortar head on the outside shall be protected from air and sun with a proper covering until satisfactorily cured.

#### 2.3.3 Precast Concrete Segmental Blocks

Precast concrete segmental block shall conform to ASTM C 139, not more than 200 mm (8 inches) thick, not less than 200 mm (8 inches) long, and of such shape that joints can be sealed effectively and bonded with cement mortar.

#### 2.3.4 Brick

Brick shall conform to ASTM C 62, Grade SW; ASTM C 55, Grade S-I or S-II; or ASTM C 32, Grade MS. Mortar for jointing and plastering shall consist of one part portland cement and two parts fine sand. Lime may be added to the mortar in a quantity not more than 25 percent of the volume of cement. The joints shall be filled completely and shall be smooth and free from surplus mortar on the inside of the structure. Brick structures shall be plastered with 10 mm of mortar over the entire outside surface of the walls. For square or rectangular structures, brick shall be laid in stretcher courses with a header course every sixth course. For round structures, brick shall be laid radially with every sixth course a stretcher course.

#### 2.3.5 Precast Reinforced Concrete Manholes

Precast reinforced concrete manholes shall conform to ASTM C 478M. Joints between precast concrete risers and tops shall be full-bedded in cement mortar and shall be smoothed to a uniform surface on both interior and exterior of the structure.

#### 2.3.6 Prefabricated Corrugated Metal Manholes

Manholes shall be of the type and design recommended by the manufacturer. Manholes shall be complete with frames and cover, or frames and gratings.

#### 2.3.7 Frame and Cover for Gratings

Frame and cover for gratings shall be cast gray iron, ASTM A 48M, Class 35B; cast ductile iron, ASTM A 536, Grade 65-45-12; or cast aluminum, ASTM B 26/B 26M, Alloy 356.OT6. Weight, shape, size, and waterway openings for grates and curb inlets shall be as indicated on the plans.

#### 2.3.8 Joints

##### 2.3.8.1 Flexible Watertight Joints

- a. Materials: Flexible watertight joints shall be made with plastic or rubber-type gaskets for concrete pipe and with factory-fabricated resilient materials for clay pipe. The design of joints and the physical requirements for plastic gaskets shall conform to AASHTO M 198, and rubber-type gaskets shall conform to ASTM C 443M. Factory-fabricated resilient joint materials shall conform to ASTM C 425. Gaskets shall have not more than one factory-fabricated splice, except that two factory-fabricated splices of the rubber-type gasket are permitted if the nominal diameter of the pipe being gasketed exceeds 1.35 m (54 inches).
- b. Test Requirements: Watertight joints shall be tested and shall meet test requirements of paragraph HYDROSTATIC TEST ON WATERTIGHT JOINTS. Rubber gaskets shall comply with the oil resistant gasket requirements of ASTM C 443M. Certified copies of test results shall be delivered to the Contracting Officer before gaskets or jointing materials are installed. Alternate types of watertight joint may be furnished, if specifically approved.

##### 2.3.8.2 External Sealing Bands

Requirements for external sealing bands shall conform to ASTM C 877M.

##### 2.3.8.3 Flexible Watertight, Gasketed Joints

- a. Gaskets: When infiltration or exfiltration is a concern for pipe lines, the couplings may be required to have gaskets. The closed-cell expanded rubber gaskets shall be a continuous band approximately 178 mm (7 inches) wide and approximately 10 mm (3/8 inch) thick, meeting the requirements of ASTM D 1056, Type 2 B3, and shall have a quality retention rating of not less than 70 percent when tested for weather resistance by ozone chamber exposure, Method B of ASTM D 1171. Rubber O-ring gaskets shall be 21 mm (13/16 inch) in diameter for pipe diameters of 914 mm (36 inches) or smaller and 22 mm (7/8 inch) in diameter for larger pipe having 13 mm (1/2 inch) deep end corrugation. Rubber O-ring gaskets shall be 35 mm (1-3/8 inches) in diameter for pipe having 25 mm (1 inch) deep end corrugations. O-rings shall meet the requirements of AASHTO M 198 or ASTM C 443. Flexible plastic gaskets shall conform to requirements of AASHTO M 198, Type B.

- b. Connecting Bands: Connecting bands shall be of the type, size and sheet thickness of band, and the size of angles, bolts, rods and lugs as indicated or where not indicated as specified in the applicable standards or specifications for the pipe. Exterior rivet heads in the longitudinal seam under the connecting band shall be countersunk or the rivets shall be omitted and the seam welded. Watertight joints shall be tested and shall meet the test requirements of paragraph HYDROSTATIC TEST ON WATERTIGHT JOINTS.

#### 2.3.8.4 PVC Plastic Pipes

Joints shall be solvent cement or elastomeric gasket type in accordance with the specification for the pipe and as recommended by the pipe manufacturer.

#### 2.3.8.5 Smooth Wall PE Plastic Pipe

Pipe shall be joined using butt fusion method as recommended by the pipe manufacturer.

#### 2.3.8.6 Corrugated PE Plastic Pipe

Water tight joints shall be made using a PVC or PE coupling and rubber gaskets as recommended by the pipe manufacturer. Rubber gaskets shall conform to ASTM F 477. Soil tight joints shall conform to the requirements in AASHTO HB-16, Division II, Section 26.4.2.4. (e) for soil tightness and shall be as recommended by the pipe manufacturer.

#### 2.3.8.7 Profile Wall PE Plastic Pipe

Joints shall be gasketed or thermal weld type with integral bell in accordance with ASTM F 894.

#### 2.3.8.8 Ductile Iron Pipe

Couplings and fittings shall be as recommended by the pipe manufacturer.

### 2.4 STEEL LADDER

Steel ladder shall be provided where the depth of the manhole exceeds 3.66 m (12 feet). These ladders shall be not less than 406 mm (16 inches) in width, with 19 mm (3/4 inch) diameter rungs spaced 305 mm (12 inches) apart. The two stringers shall be a minimum 10 mm (3/8 inch) thick and 63 mm (2-1/2 inches) wide. Ladders and inserts shall be galvanized after fabrication in conformance with ASTM A 123/A 123M.

### 2.5 DOWNSPOUT BOOTS

Boots used to connect exterior downspouts to the storm-drainage system shall be of gray cast iron conforming to ASTM A 48M, Class 30B or 35B. Shape and size shall be as indicated.

### 2.6 RESILIENT CONNECTORS

Flexible, watertight connectors used for connecting pipe to manholes and inlets shall conform to ASTM C 923.

## 2.7 HYDROSTATIC TEST ON WATERTIGHT JOINTS

### 2.7.1 Concrete, Clay, PVC and PE Pipe

A hydrostatic test shall be made on the watertight joint types as proposed.

Only one sample joint of each type needs testing; however, if the sample joint fails because of faulty design or workmanship, an additional sample joint may be tested. During the test period, gaskets or other jointing material shall be protected from extreme temperatures which might adversely affect the performance of such materials. Performance requirements for joints in reinforced and nonreinforced concrete pipe shall conform to AASHTO M 198 or ASTM C 443M. Test requirements for joints in clay pipe shall conform to ASTM C 425. Test requirements for joints in PVC and PE plastic pipe shall conform to ASTM D 3212.

### 2.7.2 Corrugated Steel and Aluminum Pipe

A hydrostatic test shall be made on the watertight joint system or coupling band type proposed. The moment strength required of the joint is expressed as 15 percent of the calculated moment capacity of the pipe on a transverse section remote from the joint by the AASHTO HB-16 (Division II, Section 26). The pipe shall be supported for the hydrostatic test with the joint located at the point which develops 15 percent of the moment capacity of the pipe based on the allowable span in meters for the pipe flowing full or 54,233 Newton meters (40,000 foot-pounds), whichever is less. Performance requirements shall be met at an internal hydrostatic pressure of 69 kPa (10 psi) for a 10 minute period for both annular corrugated metal pipe and helical corrugated metal pipe with factory reformed ends.

## PART 3 EXECUTION

### 3.1 EXCAVATION FOR PIPE CULVERTS, STORM DRAINS, AND DRAINAGE STRUCTURES

Excavation of trenches, and for appurtenances and backfilling for culverts and storm drains, shall be in accordance with the applicable portions of Section 02316 "Excavation, Trenching, and Backfilling for Utilities Systems" and the requirements specified below.

#### 3.1.1 Trenching

The width of trenches at any point below the top of the pipe shall be not greater than the outside diameter of the pipe plus 600 mm to permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe. Sheet piling and bracing, where required, shall be placed within the trench width as specified. Contractor shall not overexcavate. Where trench widths are exceeded, redesign with a resultant increase in cost of stronger pipe or special installation procedures will be necessary.

Cost of this redesign and increased cost of pipe or installation shall be borne by the Contractor without additional cost to the Government.

### 3.1.2 Removal of Rock

Rock in either ledge or boulder formation shall be replaced with suitable materials to provide a compacted earth cushion having a thickness between unremoved rock and the pipe of at least 200 mm or 13 mm for each meter of fill over the top of the pipe, whichever is greater, but not more than three-fourths the nominal diameter of the pipe. Where bell-and-spigot pipe is used, the cushion shall be maintained under the bell as well as under the straight portion of the pipe. Rock excavation shall be as specified and defined in Section 02316 "Excavation, Trenching, and Backfilling for Utilities Systems".

### 3.1.3 Removal of Unstable Material

Where wet or otherwise unstable soil incapable of properly supporting the pipe, as determined by the Contracting Officer, is unexpectedly encountered in the bottom of a trench, such material shall be removed to the depth required and replaced to the proper grade with select granular material, compacted as provided in paragraph BACKFILLING. When removal of unstable material is due to the fault or neglect of the Contractor in his performance of shoring and sheeting, water removal, or other specified requirements, such removal and replacement shall be performed at no additional cost to the government.

## 3.2 BEDDING

The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe.

### 3.2.1 Concrete Pipe Requirements

When no bedding class is specified or detailed on the drawings, concrete pipe shall be bedded in a soil foundation accurately shaped and rounded to conform to the lowest one-fourth of the outside portion of circular pipe or to the lower curved portion of pipe arch for the entire length of the pipe or pipe arch. When necessary, the bedding shall be tamped. Bell holes and depressions for joints shall be not more than the length, depth, and width required for properly making the particular type of joint.

### 3.2.2 Clay Pipe Requirements

Bedding for clay pipe shall be as specified by ASTM C 12.

### 3.2.3 Corrugated Metal Pipe

Bedding for corrugated metal pipe and pipe arch shall be in accordance with ASTM A 798/A 798M. It is not required to shape the bedding to the pipe geometry. However, for pipe arches, the Contractor shall either shape the bedding to the relatively flat bottom arc or fine grade the foundation to a shallow v-shape. Bedding for corrugated structural plate pipe shall meet requirements of ASTM A 807.

### 3.2.4 Ductile Iron Pipe



Bedding for ductile iron pipe shall be as shown on the drawings.

### 3.2.5 Plastic Pipe

Bedding for PVC and PE pipe shall meet the requirements of ASTM D 2321. Bedding, haunching, and initial backfill shall be either Class IB or II material.

### 3.3 PLACING PIPE

Each pipe shall be thoroughly examined before being laid; defective or damaged pipe shall not be used. Plastic pipe shall be protected from exposure to direct sunlight prior to laying, if necessary to maintain adequate pipe stiffness and meet installation deflection requirements. Pipelines shall be laid to the grades and alignment indicated. Proper facilities shall be provided for lowering sections of pipe into trenches. Lifting lugs in vertically elongated metal pipe shall be placed in the same vertical plane as the major axis of the pipe. Pipe shall not be laid in water, and pipe shall not be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches during construction shall be provided as necessary. Deflection of installed flexible pipe shall not exceed the following limits:

TYPE OF PIPE	MAXIMUM ALLOWABLE DEFLECTION (%)
Corrugated Steel and Aluminum Alloy	5
Concrete-Lined Corrugated Steel	3
Ductile Iron Culvert	3
Plastic	7.5

Not less than 30 days after the completion of backfilling, the Government may perform a deflection test on the entire length of installed flexible pipe using a mandrel or other suitable device. Installed flexible pipe showing deflections greater than those indicated above shall be retested by a run from the opposite direction. If the retest also fails, the suspect pipe shall be replaced at no cost to the Government.

#### 3.3.1 Concrete, Clay, PVC, Ribbed PVC and Ductile Iron Pipe

Laying shall proceed upgrade with spigot ends of bell-and-spigot pipe and tongue ends of tongue-and-groove pipe pointing in the direction of the flow.

#### 3.3.2 Elliptical and Elliptical Reinforced Concrete Pipe

The manufacturer's reference lines, designating the top of the pipe, shall be within 5 degrees of a vertical plane through the longitudinal axis of the pipe, during placement. Damage to or misalignment of the pipe shall be prevented in all backfilling operations.

### 3.3.3 Corrugated PE Pipe

Laying shall be with the separate sections joined firmly on a bed shaped to line and grade and shall follow manufacturer's recommendations.

### 3.3.4 Corrugated Metal Pipe and Pipe Arch

Laying shall be with the separate sections joined firmly together, with the outside laps of circumferential joints pointing upstream, and with longitudinal laps on the sides. Part paved pipe shall be installed so that the centerline of bituminous pavement in the pipe, indicated by suitable markings on the top at each end of the pipe sections, coincides with the specified alignment of pipe. Fully paved steel pipe or pipe arch shall have a painted or otherwise applied label inside the pipe or pipe arch indicating sheet thickness of pipe or pipe arch. Any unprotected metal in the joints shall be coated with bituminous material as specified in AASHTO M 190 or AASHTO M 243. Interior coating shall be protected against damage from insertion or removal of struts or tie wires. Lifting lugs shall be used to facilitate moving pipe without damage to exterior or interior coatings. During transportation and installation, pipe or pipe arch and coupling bands shall be handled with care to preclude damage to the coating, paving or lining. Damaged coatings, pavings and linings shall be repaired in accordance with the manufacturer's recommendations prior to placing backfill. Pipe on which coating, paving or lining has been damaged to such an extent that satisfactory field repairs cannot be made shall be removed and replaced. Vertical elongation, where indicated, shall be accomplished by factory elongation. Suitable markings or properly placed lifting lugs shall be provided to ensure placement of factory elongated pipe in a vertical plane.

### 3.3.5 Structural-Plate Steel

Structural plate shall be installed in accordance with ASTM A 807. Structural plate shall be assembled in accordance with instructions furnished by the manufacturer. Instructions shall show the position of each plate and the order of assembly. Bolts shall be tightened progressively and uniformly, starting at one end of the structure after all plates are in place. The operation shall be repeated to ensure that all bolts are tightened to meet the torque requirements of 270 Newton meters (200 foot-pounds) plus or minus 68 Newton meters (50 foot-pounds). Any power wrenches used shall be checked by the use of hand torque wrenches or long-handled socket or structural wrenches for amount of torque produced. Power wrenches shall be checked and adjusted frequently as needed, according to type or condition, to ensure proper adjustment to supply the required torque.

### 3.3.6 Structural-Plate Aluminum

Structural plate shall be assembled in accordance with instructions furnished by the manufacturer. Instructions shall show the position of each plate and the order of assembly. Bolts shall be tightened progressively and uniformly, starting at one end of the structure after all plates are in place. The operation shall be repeated to ensure that all

bolts are torqued to a minimum of 136 Newton meters (100 foot-pounds) on aluminum alloy bolts and a minimum of 203 Newton meters (150 foot-pounds) on galvanized steel bolts. Any power wrenches used shall be checked by the use of hand torque wrenches or long-handled socket or structural wrenches for the amount of torque produced. Power wrenches shall be checked and adjusted as frequently as needed, according to type or condition, to ensure that they are in proper adjustment to supply the required torque.

#### 3.3.7 Multiple Culverts

Where multiple lines of pipe are installed, adjacent sides of pipe shall be at least half the nominal pipe diameter or 1 meter apart, whichever is less.

#### 3.3.8 Jacking Pipe Through Fills

Methods of operation and installation for jacking pipe through fills shall conform to requirements specified in Volume 1, Chapter 1, Part 4 of AREMA Manual.

### 3.4 JOINTING

#### 3.4.1 Concrete and Clay Pipe

##### 3.4.1.1 Cement-Mortar Bell-and-Spigot Joint

The first pipe shall be bedded to the established gradeline, with the bell end placed upstream. The interior surface of the bell shall be thoroughly cleaned with a wet brush and the lower portion of the bell filled with mortar as required to bring inner surfaces of abutting pipes flush and even. The spigot end of each subsequent pipe shall be cleaned with a wet brush and uniformly matched into a bell so that sections are closely fitted. After each section is laid, the remainder of the joint shall be filled with mortar, and a bead shall be formed around the outside of the joint with sufficient additional mortar. If mortar is not sufficiently stiff to prevent appreciable slump before setting, the outside of the joint shall be wrapped or bandaged with cheesecloth to hold mortar in place.

##### 3.4.1.2 Cement-Mortar Oakum Joint for Bell-and-Spigot Pipe

A closely twisted gasket shall be made of jute or oakum of the diameter required to support the spigot end of the pipe at the proper grade and to make the joint concentric. Joint packing shall be in one piece of sufficient length to pass around the pipe and lap at top. This gasket shall be thoroughly saturated with neat cement grout. The bell of the pipe shall be thoroughly cleaned with a wet brush, and the gasket shall be laid in the bell for the lower third of the circumference and covered with mortar. The spigot of the pipe shall be thoroughly cleaned with a wet brush, inserted in the bell, and carefully driven home. A small amount of mortar shall be inserted in the annular space for the upper two-thirds of the circumference. The gasket shall be lapped at the top of the pipe and driven home in the annular space with a caulking tool. The remainder of the annular space shall be filled completely with mortar and beveled at an angle of approximately 45 degrees with the outside of the bell. If mortar is not sufficiently stiff to prevent appreciable slump before setting, the

outside of the joint thus made shall be wrapped with cheesecloth. Placing of this type of joint shall be kept at least five joints behind laying operations.

#### 3.4.1.3 Cement-Mortar Diaper Joint for Bell-and-Spigot Pipe

The pipe shall be centered so that the annular space is uniform. The annular space shall be caulked with jute or oakum. Before caulking, the inside of the bell and the outside of the spigot shall be cleaned.

- a. Diaper Bands: Diaper bands shall consist of heavy cloth fabric to hold grout in place at joints and shall be cut in lengths that extend one-eighth of the circumference of pipe above the spring line on one side of the pipe and up to the spring line on the other side of the pipe. Longitudinal edges of fabric bands shall be rolled and stitched around two pieces of wire. Width of fabric bands shall be such that after fabric has been securely stitched around both edges on wires, the wires will be uniformly spaced not less than 200 mm apart. Wires shall be cut into lengths to pass around pipe with sufficient extra length for the ends to be twisted at top of pipe to hold the band securely in place; bands shall be accurately centered around lower portion of joint.
- b. Grout: Grout shall be poured between band and pipe from the high side of band only, until grout rises to the top of band at the spring line of pipe, or as nearly so as possible, on the opposite side of pipe, to ensure a thorough sealing of joint around the portion of pipe covered by the band. Silt, slush, water, or polluted mortar grout forced up on the lower side shall be forced out by pouring, and removed.
- c. Remainder of Joint: The remaining unfilled upper portion of the joint shall be filled with mortar and a bead formed around the outside of this upper portion of the joint with a sufficient amount of additional mortar. The diaper shall be left in place. Placing of this type of joint shall be kept at least five joints behind actual laying of pipe. No backfilling around joints shall be done until joints have been fully inspected and approved.

#### 3.4.1.4 Cement-Mortar Tongue-and-Groove Joint

The first pipe shall be bedded carefully to the established gradeline with the groove upstream. A shallow excavation shall be made underneath the pipe at the joint and filled with mortar to provide a bed for the pipe. The grooved end of the first pipe shall be thoroughly cleaned with a wet brush, and a layer of soft mortar applied to the lower half of the groove. The tongue of the second pipe shall be cleaned with a wet brush; while in horizontal position, a layer of soft mortar shall be applied to the upper half of the tongue. The tongue end of the second pipe shall be inserted in the grooved end of the first pipe until mortar is squeezed out on interior and exterior surfaces. Sufficient mortar shall be used to fill the joint completely and to form a bead on the outside.

#### 3.4.1.5 Cement-Mortar Diaper Joint for Tongue-and-Groove Pipe

The joint shall be of the type described for cement-mortar tongue-and-groove joint in this paragraph, except that the shallow excavation directly beneath the joint shall not be filled with mortar until after a gauze or cheesecloth band dipped in cement mortar has been wrapped around the outside of the joint. The cement-mortar bead at the joint shall be at least 15 mm, thick and the width of the diaper band shall be at least 200 mm. The diaper shall be left in place. Placing of this type of joint shall be kept at least five joints behind the actual laying of the pipe. Backfilling around the joints shall not be done until the joints have been fully inspected and approved.

#### 3.4.1.6 Plastic Sealing Compound Joints for Tongue-and-Grooved Pipe

Sealing compounds shall follow the recommendation of the particular manufacturer in regard to special installation requirements. Surfaces to receive lubricants, primers, or adhesives shall be dry and clean. Sealing compounds shall be affixed to the pipe not more than 3 hours prior to installation of the pipe, and shall be protected from the sun, blowing dust, and other deleterious agents at all times. Sealing compounds shall be inspected before installation of the pipe, and any loose or improperly affixed sealing compound shall be removed and replaced. The pipe shall be aligned with the previously installed pipe, and the joint pulled together. If, while making the joint with mastic-type sealant, a slight protrusion of the material is not visible along the entire inner and outer circumference of the joint when the joint is pulled up, the pipe shall be removed and the joint remade. After the joint is made, all inner protrusions shall be cut off flush with the inner surface of the pipe. If nonmastic-type sealant material is used, the "Squeeze-Out" requirement above will be waived.

#### 3.4.1.7 Flexible Watertight Joints

Gaskets and jointing materials shall be as recommended by the particular manufacturer in regard to use of lubricants, cements, adhesives, and other special installation requirements. Surfaces to receive lubricants, cements, or adhesives shall be clean and dry. Gaskets and jointing materials shall be affixed to the pipe not more than 24 hours prior to the installation of the pipe, and shall be protected from the sun, blowing dust, and other deleterious agents at all times. Gaskets and jointing materials shall be inspected before installing the pipe; any loose or improperly affixed gaskets and jointing materials shall be removed and replaced. The pipe shall be aligned with the previously installed pipe, and the joint pushed home. If, while the joint is being made the gasket becomes visibly dislocated the pipe shall be removed and the joint remade.

#### 3.4.1.8 External Sealing Band Joint for Noncircular Pipe

Surfaces to receive sealing bands shall be dry and clean. Bands shall be installed in accordance with manufacturer's recommendations.

#### 3.4.2 Corrugated Metal Pipe

##### 3.4.2.1 Field Joints

Transverse field joints shall be designed so that the successive connection of pipe sections will form a continuous line free of appreciable irregularities in the flow line. In addition, the joints shall meet the general performance requirements described in ASTM A 798/A 798M. Suitable transverse field joints which satisfy the requirements for one or more of the joint performance categories can be obtained with the following types of connecting bands furnished with suitable band-end fastening devices: corrugated bands, bands with projections, flat bands, and bands of special design that engage factory reformed ends of corrugated pipe. The space between the pipe and connecting bands shall be kept free from dirt and grit so that corrugations fit snugly. The connecting band, while being tightened, shall be tapped with a soft-head mallet of wood, rubber or plastic, to take up slack and ensure a tight joint. The annular space between abutting sections of part paved, and fully paved pipe and pipe arch, in sizes 750 mm (30 inches) or larger, shall be filled with a bituminous material after jointing. Field joints for each type of corrugated metal pipe shall maintain pipe alignment during construction and prevent infiltration of fill material during the life of the installations.

The type, size, and sheet thickness of the band and the size of angles or lugs and bolts shall be as indicated or where not indicated, shall be as specified in the applicable standards or specifications for the pipe.

#### 3.4.2.2 Flexible Watertight, Gasketed Joints

Installation shall be as recommended by the gasket manufacturer for use of lubricants and cements and other special installation requirements. The gasket shall be placed over one end of a section of pipe for half the width of the gasket. The other half shall be doubled over the end of the same pipe. When the adjoining section of pipe is in place, the doubled-over half of the gasket shall then be rolled over the adjoining section. Any unevenness in overlap shall be corrected so that the gasket covers the end of pipe sections equally. Connecting bands shall be centered over adjoining sections of pipe, and rods or bolts placed in position and nuts tightened. Band Tightening: The band shall be tightened evenly, even tension being kept on the rods or bolts, and the gasket; the gasket shall seat properly in the corrugations. Watertight joints shall remain uncovered for a period of time designated, and before being covered, tightness of the nuts shall be measured with a torque wrench. If the nut has tended to loosen its grip on the bolts or rods, the nut shall be retightened with a torque wrench and remain uncovered until a tight, permanent joint is assured.

### 3.5 DRAINAGE STRUCTURES

#### 3.5.1 Manholes and Inlets

Construction shall be of reinforced concrete, plain concrete, brick, precast reinforced concrete, precast concrete segmental blocks, prefabricated corrugated metal, or bituminous coated corrugated metal; complete with frames and covers or gratings; and with fixed galvanized steel ladders where indicated. Pipe studs and junction chambers of prefabricated corrugated metal manholes shall be fully bituminous-coated and paved when the connecting branch lines are so treated. Pipe connections to concrete manholes and inlets shall be made with flexible,

watertight connectors.

### 3.5.2 Walls and Headwalls

Construction shall be as indicated.

### 3.6 STEEL LADDER INSTALLATION

Ladder shall be adequately anchored to the wall by means of steel inserts spaced not more than 1.83 m (6 feet) vertically, and shall be installed to provide at least 152 mm (6 inches) of space between the wall and the rungs.

The wall along the line of the ladder shall be vertical for its entire length.

### 3.7 BACKFILLING

#### 3.7.1 Backfilling Pipe in Trenches

After the pipe has been properly bedded, selected material from excavation or borrow, at a moisture content that will facilitate compaction, shall be placed along both sides of pipe in layers not exceeding 150 mm in compacted depth. The backfill shall be brought up evenly on both sides of pipe for the full length of pipe. The fill shall be thoroughly compacted under the haunches of the pipe. Each layer shall be thoroughly compacted with mechanical tampers or rammers. This method of filling and compacting shall continue until the fill has reached an elevation of at least 300 mm above the top of the pipe. The remainder of the trench shall be backfilled and compacted by spreading and rolling or compacted by mechanical rammers or tampers in layers not exceeding 150 millimeters. Tests for density shall be made as necessary to ensure conformance to the compaction requirements specified below. Where it is necessary, in the opinion of the Contracting Officer, that sheeting or portions of bracing used be left in place, the contract will be adjusted accordingly. Untreated sheeting shall not be left in place beneath structures or pavements.

#### 3.7.2 Backfilling Pipe in Fill Sections

For pipe placed in fill sections, backfill material and the placement and compaction procedures shall be as specified below. The fill material shall be uniformly spread in layers longitudinally on both sides of the pipe, not exceeding 150 mm in compacted depth, and shall be compacted by rolling parallel with pipe or by mechanical tamping or ramming. Prior to commencing normal filling operations, the crown width of the fill at a height of 300 mm above the top of the pipe shall extend a distance of not less than twice the outside pipe diameter on each side of the pipe or 4 m, whichever is less. After the backfill has reached at least 300 mm above the top of the pipe, the remainder of the fill shall be placed and thoroughly compacted in layers not exceeding 150 mm.

#### 3.7.3 Movement of Construction Machinery

When compacting by rolling or operating heavy equipment parallel with the pipe, displacement of or injury to the pipe shall be avoided. Movement of construction machinery over a culvert or storm drain at any stage of

construction shall be at the Contractor's risk. Any damaged pipe shall be repaired or replaced.

#### 3.7.4 Compaction

##### 3.7.4.1 General Requirements

Cohesionless materials include gravels, gravel-sand mixtures, sands, and gravelly sands. Cohesive materials include clayey and silty gravels, gravel-silt mixtures, clayey and silty sands, sand-clay mixtures, clays, silts, and very fine sands. When results of compaction tests for moisture-density relations are recorded on graphs, cohesionless soils will show straight lines or reverse-shaped moisture-density curves, and cohesive soils will show normal moisture-density curves.

##### 3.7.4.2 Minimum Density

Backfill over and around the pipe and backfill around and adjacent to drainage structures shall be compacted at the approved moisture content to the following applicable minimum density, which will be determined as specified below.

- a. Under airfield and heliport pavements, paved roads, streets, parking areas, and similar-use pavements including adjacent shoulder areas, the density shall be not less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material, up to the elevation where requirements for pavement subgrade materials and compaction shall control.
- b. Under unpaved or turfed traffic areas, density shall not be less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material.
- c. Under nontraffic areas, density shall be not less than that of the surrounding material.

##### 3.7.5 Determination of Density

Testing shall be the responsibility of the Contractor and performed at no additional cost to the Government. Testing shall be performed by an approved commercial testing laboratory or by the Contractor subject to approval. Tests shall be performed in sufficient number to ensure that specified density is being obtained. Laboratory tests for moisture-density relations shall be made in accordance with ASTM D 1557 except that mechanical tampers may be used provided the results are correlated with those obtained with the specified hand tamper. Field density tests shall be determined in accordance with ASTM D 2167 or ASTM D 2922. When ASTM D 2922 is used, the calibration curves shall be checked and adjusted, if necessary, using the sand cone method as described in paragraph Calibration of the referenced publications. ASTM D 2922 results in a wet unit weight of soil and when using this method ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks



as described in ASTM D 3017 or ASTM D 2922. Test results shall be furnished the Contracting Officer. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job on each different type of material encountered and at intervals as directed.

### 3.8 PIPELINE TESTING

Lines shall be tested for leakage by low pressure air or water testing or exfiltration tests, as appropriate. Low pressure air testing for vitrified clay pipes shall conform to ASTM C 828. Low pressure air testing for concrete pipes shall conform to ASTM C 924M. Low pressure air testing for plastic pipe shall conform to ASTM F 1417. Low pressure air testing procedures for other pipe materials shall use the pressures and testing times prescribed in ASTM C 828 or ASTM C 924M, after consultation with the pipe manufacturer. Testing of individual joints for leakage by low pressure air or water shall conform to ASTM C 1103M. Prior to exfiltration tests, the trench shall be backfilled up to at least the lower half of the pipe. If required, sufficient additional backfill shall be placed to prevent pipe movement during testing, leaving the joints uncovered to permit inspection. Visible leaks encountered shall be corrected regardless of leakage test results. When the water table is 600 mm or more above the top of the pipe at the upper end of the pipeline section to be tested, infiltration shall be measured using a suitable weir or other device acceptable to the Contracting Officer. An exfiltration test shall be made by filling the line to be tested with water so that a head of at least 600 mm is provided above both the water table and the top of the pipe at the upper end of the pipeline to be tested. The filled line shall be allowed to stand until the pipe has reached its maximum absorption, but not less than 4 hours. After absorption, the head shall be reestablished. The amount of water required to maintain this water level during a 2-hour test period shall be measured. Leakage as measured by the exfiltration test shall not exceed 60 liters per mm in diameter per kilometer (250 gallons per inch in diameter per mile) of pipeline per day or 9 mL per mm in diameter per 100 meters (0.2 gallons per inch in diameter per 100 feet) of pipeline per hour. When leakage exceeds the maximum amount specified, satisfactory correction shall be made and retesting accomplished. Testing, correcting, and retesting shall be made at no additional cost to the Government.

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## SECTION 02700

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## SECTION 02700

## SIDE DRAINS

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS  
(AASHTO)

AASHTO M 198	(1998) Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets
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AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 76	(2000) Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C 270	(2000) Mortar for Unit Masonry
ASTM C 443M	(1998) Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets (Metric)
ASTM C 655	(2000) Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe
ASTM C 828	(1998) Low-Pressure Air Test of Vitrified Clay Pipe Lines
ASTM C 924M	(1998) Concrete Pipe Sewer Lines by Low-Pressure Air Test Method (Metric)
ASTM C 1103M	(1994) Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines (Metric)
ASTM D 1556	(2000) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(2000) Laboratory Compaction Characteristics of Soil Using Modified

Effort (56,000 ft-lbf/cu. ft. (2,700  
kN-m/cu.m.))

ASTM F 1417

(1992; R 1998) Installation Acceptance of  
Plastic Gravity Sewer Lines Using  
Low-Pressure Air

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

### SD-02 Shop Drawings

Placing Pipe; G, RE.

Printed copies of the manufacturer's recommendations for installation procedures of the material being placed, prior to installation.

### SD-06 Test Reports

Pipeline Testing; G, RE.

Certified copies of test reports demonstrating conformance to applicable pipe specifications, before pipe is installed.

## 1.3 DELIVERY, STORAGE, AND HANDLING OF MATERIALS.

### 1.3.1 Delivery and Storage.

Materials delivered to site shall be inspected for damage, unloaded, and stored with the minimum of handling. Do not store materials directly on the ground. Inside of pipes and fittings shall be kept free of dirt and debris. Gasket materials and plastic materials shall be protected from exposure to the direct sunlight over extended periods.

### 1.3.2 Handling.

Materials shall be handled in such a manner as to insure delivery to the trench in sound undamaged condition. Pipe shall be carried to the trench not dragged.

## PART 2 PRODUCTS.

### 2.1 PIPE FOR SIDE DRAINS.

Pipe for side drains shall be of the sizes indicated and shall conform to the requirements specified.

#### 2.1.1 Concrete Pipe.

Concrete pipe shall conform to ASTM C 76, Class III or IV or to ASTM C 655 with a D-Load equal to or greater than that indicated to produce a 0.3 mm crack.

## 2.2 MISCELLANEOUS MATERIALS.

### 2.2.1 Concrete.

Unless otherwise specified, concrete and reinforced concrete shall conform to the requirements for 25 Mpa concrete under Section 03301 CAST-IN-PLACE STRUCTURAL CONCRETE.

### 2.2.2 Joints.

#### 2.2.2.1 Mortar joints.

Mortar for pipe joints, connections to other drainage structures, and brick or block construction shall conform to ASTM C 270, Type M, except the maximum placement time shall be 1 hour. The quantity of water in the mixture shall be sufficient to produce a stiff workable mortar. Water shall be clean and free of harmful acids, alkalies, and organic impurities. The mortar shall be used within 30 minutes after the ingredients are mixed with water. The inside of the joint shall be wiped clean and finished smooth. The mortar head on the outside shall be protected from air and sun with a proper covering until satisfactorily cured.

#### 2.2.2.2 Flexible Watertight Joints For Concrete Pipe.

Flexible watertight joints shall be made with plastic or rubber-type gaskets for concrete pipe. The design of joints and the physical requirements for plastic gaskets shall conform to AASHTO M 198, and rubber-type gaskets shall conform to ASTM C 443M. Gaskets shall have not more than one factory-fabricated splice, except that two factory-fabricated splices of the rubber-type gasket are permitted if the nominal diameter of the pipe being gasketed exceeds 1.35 meters.

## PART 3 EXECUTION.

### 3.1 EXCAVATION FOR PIPE SIDE DRAINS AND DRAINAGE STRUCTURES.

Excavation of trenches and for appurtenances and backfilling for culverts and storm drains shall be in accordance with the applicable portions of Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS and the requirements specified below.

#### 3.1.1 Trenching.

The width of trenches at any point below the top of the pipe shall be not greater than the outside diameter of the pipe plus 150 mm to permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe. Sheet piling and bracing where required shall be placed within the trench width as specified. Care shall be taken not to overexcavate.

### 3.1.2 REMOVAL OF ROCK.

Rock in either ledge or boulder formation shall be replaced with suitable materials to provide a compacted earth cushion having a thickness between unremoved rock and the pipe of at least 200 mm or 85 mm for each meter of fill over the top of the pipe, whichever is greater, but not more than three-fourths the nominal diameter of the pipe. Where bell-and-spigot pipe is used, the cushion shall be maintained under the bell as well as under the straight portion of the pipe. Unless otherwise specified, material used to replace unstable material or rock excavation should be compacted to a minimum density of 90 percent for cohesive soils and 95 percent for noncohesive soils, as determined by ASTM D 1557. Rock excavation shall be as specified and defined in Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.

### 3.1.3 Removal of Unstable Material.

Where wet or otherwise unstable soil incapable of properly supporting the pipe, as determined by the Contracting Officer, is unexpectedly encountered in the bottom of a trench, such material shall be removed to the depth required and replaced to the proper grade with select granular material, compacted as provided in paragraph REMOVAL OF ROCK. When removal of unstable material is due to the fault or neglect of the Contractor in his performance of shoring and sheeting, water removal, or other specified requirements, such removal and replacement shall be performed at no additional cost to the government.

## 3.2 BEDDING.

### 3.2.1 Concrete Pipe.

The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe. When no bedding class is specified or detailed on the drawings, concrete pipe shall be bedded carefully in a soil foundation accurately shaped and rounded to conform to the lowest one-fourth of the outside portion of circular pipe or to the lower curved portion of pipe arch for the entire length of the pipe or pipe arch. When necessary, the bedding shall be tamped. Bell holes and depressions for joints shall be only of such length, depth, and width as required for properly making the particular type of joint.

## 3.3 PLACING PIPE.

Each pipe shall be carefully examined before being laid, and defective or damaged pipe shall not be used. Pipelines shall be laid to the grades and alignment indicated. Proper facilities shall be provided for lowering sections of pipe into trenches. Under no circumstances shall pipe be laid in water, and no pipe shall be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches during construction shall be provided as necessary. All pipe in place shall be inspected before backfilling, and those pipes damaged during placement shall be removed and replaced at no cost to the Government.

### 3.3.1 Concrete Pipe.

Laying shall proceed upgrade with spigot ends of bell-and-spigot pipe and tongue ends of tongue-and-groove pipe pointing in the direction of the flow.

### 3.4 JOINTS.

#### 3.4.1 Cement-Mortar Bell-and-Spigot Joint.

The first pipe shall be bedded to the established gradeline, with the bell end placed upstream. The interior surface of the bell shall be carefully cleaned with a wet brush and the lower portion of the bell filled with mortar to such depth as to bring inner surfaces of abutting pipes flush and even. The spigot end of each subsequent pipe shall be cleaned with a wet brush and uniformly matched into a bell so that sections are closely fitted. After each section is laid, the remainder of the joint shall be filled with mortar, and a bead shall be formed around the outside of the joint with sufficient additional mortar. If mortar is not sufficiently stiff to prevent appreciable slump before setting, the outside of the joint shall be wrapped or bandaged with cheesecloth to hold mortar in place.

#### 3.4.2 Cement-Mortar Tongue-and-Groove Joint.

The first pipe shall be bedded carefully to the established gradeline with the groove upstream. A shallow excavation shall be made underneath the pipe at the joint and filled with mortar to provide a bed for the pipe. The grooved end of the first pipe shall be carefully cleaned with a wet brush, and a layer of soft mortar applied to the lower half of the groove. The tongue of the second pipe shall be cleaned carefully with a wet brush; while in horizontal position, a layer of soft mortar shall be applied to the upper half of the tongue. The tongue end of the second pipe then shall be inserted in the grooved end of the first pipe until mortar is squeezed out on interior and exterior surfaces. Sufficient mortar shall be used to fill the joint completely and to form a bead on the outside.

#### 3.4.3 Flexible Watertight Joints For Concrete Pipe.

Flexible watertight plastic or rubber gasketed joints may be used in lieu of other type of joints. Gaskets and jointing materials shall be as recommended by the particular manufacturer in regard to use of lubricants, cements, adhesives, and other special installation requirements. Surfaces to receive lubricants, cements, or adhesives shall be clean and dry. Gaskets and jointing materials shall be affixed to the pipe not more than 24 hours prior to the installation of the pipe, and shall be protected from the sun, blowing dust, and other deleterious agents at all times. Gaskets and jointing materials shall be inspected before installing the pipe; any loose or improperly affixed gaskets and jointing materials shall be removed and replaced. The pipe shall be aligned with the previously installed pipe and the joint pushed home. If, while the joint is being made, the gasket becomes visibly dislocated, the pipe shall be removed and the joint remade.

### 3.5 SIDE DRAIN.

#### 3.5.1 Side Drain Junction Structures.



Side drain pipes and stubout pipes shall join the outlet channel with junction structures. Construction of junction structures shall be of reinforced concrete complete as shown on the drawings.

### 3.6 BACKFILLING.

#### 3.6.1 Backfilling Pipe in Trenches.

After the bedding has been prepared and the pipe installed, selected material from the required excavation at a moisture content that will facilitate compaction, shall be placed along both sides of pipe in layers not exceeding 150 mm in compacted depth. The backfill shall be brought up evenly on both sides of pipe for the full length of pipe. Care shall be taken to insure thorough compaction of the fill under the haunches of the pipe. Each layer shall be thoroughly compacted with mechanical tampers or rammers. This method of filling and compacting shall continue until the fill has reached an elevation of at least 600 mm above the top of the pipe.

The remainder of the trench shall be backfilled and compacted by spreading and rolling or compacted by mechanical rammers or tampers in layers not exceeding 150 mm and compacted to not less than 90 percent for cohesive material and 95 percent of maximum density for cohesionless material, of maximum density ASTM D 1557. In place densities shall be determined using ASTM D 1556. Where it is necessary in the opinion of the Contracting Officer, any sheeting and/or portions of bracing used shall be left in place, and the contract will be adjusted accordingly. Untreated sheeting shall not be left in place beneath structures or pavements.

#### 3.6.2 Backfilling Pipe in Fill Sections.

For pipe placed in fill sections, backfill material and the placement and compaction procedures shall be as specified above. The fill material shall be uniformly spread in layers longitudinally on both sides of pipe, not exceeding 150 mm in compacted depth, and shall be compacted by rolling parallel with pipe or by mechanical tamping or ramming. Prior to commencing normal filling operations, the crown width of the fill at a height of 300 mm above the top of the pipe shall extend a distance of not less than twice the outside pipe diameter on each side of the pipe or 4 meters, whichever is less.

#### 3.6.3 Movement of Construction Machinery.

Operating heavy equipment parallel with the pipe, displacement of or injury to the pipe shall be avoided. Movement of construction machinery over a culvert or storm drain at any stage of the construction shall be at the Contractor's risk. Any pipe damaged thereby shall be repaired or replaced at the expense of the Contractor.

### 3.7 PIPELINE TESTING

Lines shall be tested for leakage by low pressure air or water testing or exfiltration tests, as appropriate. Low pressure air testing for concrete pipes shall conform to ASTM C 924M. Low pressure air testing for plastic pipe shall conform to ASTM F 1417. Low pressure air testing procedures for other pipe materials shall use the pressures and testing times prescribed

in ASTM C 828 or ASTM C 924M, after consultation with the pipe manufacturer. Testing of individual joints for leakage by low pressure air or water shall conform to ASTM C 1103M. Prior to exfiltration tests, the trench shall be backfilled up to at least the lower half of the pipe. If required, sufficient additional backfill shall be placed to prevent pipe movement during testing, leaving the joints uncovered to permit inspection.

Visible leaks encountered shall be corrected regardless of leakage test results. When the water table is 600 mm or more above the top of the pipe at the upper end of the pipeline section to be tested, infiltration shall be measured using a suitable weir or other device acceptable to the Contracting Officer. An exfiltration test shall be made by filling the line to be tested with water so that a head of at least 600 mm is provided above both the water table and the top of the pipe at the upper end of the pipeline to be tested. The filled line shall be allowed to stand until the pipe has reached its maximum absorption, but not less than 4 hours. After absorption, the head shall be reestablished. The amount of water required to maintain this water level during a 2-hour test period shall be measured.

Leakage as measured by the exfiltration test shall not exceed 60 liters per mm in diameter per kilometer (250 gallons per inch in diameter per mile) of pipeline per day or 9 mL per mm in diameter per 100 meters (0.2 gallons per inch in diameter per 100 feet) of pipeline per hour. When leakage exceeds the maximum amount specified, satisfactory correction shall be made and retesting accomplished. Testing, correcting, and retesting shall be made at no additional cost to the Government.

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SECTION 02709

WEEP HOLE SYSTEM

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## SECTION 02709

## WEEP HOLE SYSTEM

## PART 1 GENERAL

NOTE - The term Geotextile and Filter Fabric and Filter Material are meant to be the same in this specification section.

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 131	(1996) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM D 75	(1987; R 1997) Sampling Aggregates
ASTM D 4632	(1991; R 1997) Grab Breaking Load and Elongation of Geotextiles
ASTM D 4833	(1988) Test Method for Index Puncture Resistance of Geotextiles, Geomembrane, and Related Products

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Samples

Filter Material.

Specimens identified to indicate the manufacturer, type of material, size and quantity of material, and shipment or lot represented. Each sample of filter material shall be a piece not less than 150 mm x 150 mm.

## PART 2 PRODUCTS

## 2.1 DRAIN MATERIAL

Drain material shall be durable, hard, tough, and free from adherent coatings. The material shall not contain corrosive agents, organic matter, or soft, friable, thin or elongated particles in quantities considered deleterious by the Contracting Officer. Drain material shall consist of gravel, crushed stone, or processed crushed concrete, and shall show a loss in weight of not more than 50 percent when tested in accordance with ASTM C 131, and shall be reasonably well graded within the following limits:

Sieve Size (millimeters)	Percent by Weight Passing
25 mm	100
19 mm	90-100
9.5 mm	20-55
4.75 mm	0-10
150 um	0-4
75 um	0-2

## 2.2 FILTER FABRIC

Filter fabric shall be a nonwoven needle punch pervious sheet of plastic yarn. The filter fabric shall provide an apparent opening size no finer than the No. 100 (150-mm) sieve and no coarser than the No. 50 (300-mm) sieve. The filter fabric shall have a minimum tensile strength of 100 pounds in any principal direction when tested in accordance with ASTM D 4632 grab test method using 25mm square jaws and a 0.3 meter per minute constant rate of traverse. The filter fabric shall have a 15 percent minimum breaking elongation in any principal direction when tested in accordance with ASTM D 4632. The filter fabric shall have a 22.5 killogram minimum puncture strength when tested in accordance with ASTM D 4833. The filter fabric shall have no seams. The Contractor shall submit Filter Material samples prior to use of the material.

## PART 3 EXECUTION

### 3.1 INSTALLATION

#### 3.1.1 Drain Material

Drain material for weep holes shall be wrapped completely in filter fabric and placed immediately against the wall, covering the opening of the weep hole.

#### 3.1.2 Installation of the Filter Fabric

The filter fabric shall be placed in the manner and at the location indicated. The Contractor shall submit a plan for installation of filter fabric in front of channel weep holes for approval by the Contracting Officer. At the time of installation, the filter fiber shall be rejected if it has defects, rips, holes, flaws, deterioration or damage incurred during manufacture, transportation or storage. The surface to receive the filter fabric shall be prepared to a relatively smooth condition free of

obstruction, depressions, debris and soft or low density pockets of material. The filter fabric shall be placed smooth and free of tension, stress, or wrinkles. The filter fabric shall be placed to provide a minimum overlap of 0.3 meters at each joint. Temporary pinning of the textile to help hold it in place shall be allowed. The temporary pins shall be removed during placement of materials on the filter fabric to relieve high tensile stress. The filter fabric shall be protected at all times during construction from contamination by surface runoff and any filter fabric so contaminated shall be removed and replaced with uncontaminated filter fabric. Any damage to the filter fabric during its installation or during placement of drain material or compacted fill shall be replaced by the Contractor at no cost to the Government. The work shall be scheduled so that the covering of the filter fabric with a layer of the specified material is accomplished within 7 days after placement of the filter fabric. Failure to comply shall require replacement of filter fabric. The filter fabric shall be protected from damage prior to and during the placement of drain material or compacted fill by limiting the height of drop to less than 0.3 meters. Before placement of drain material or compacted fill, the Contractor shall demonstrate that the placement technique will prevent damage to the filter fabric. In no case shall any type of equipment be allowed on the unprotected filter fabric.

### 3.1.3 Shipment and Storage

During all period of shipment and storage, the filter fabric shall be protected from direct sunlight, ultra-violet rays, temperatures greater than 140 degrees Fahrenheit, mud, dirt, dust and debris. To the extent possible shall be maintained wrapped in a heavy duty protective covering.

## 3.2 TESTS

### 3.2.1 Drain Material

#### 3.2.1.1 Points

Points on the individual grading curves obtained from representative samples of the drain material not only shall lie between the boundary limits as defined by smooth curves drawn through the tabulated grading limits plotted on a mechanical-analysis diagram but also shall exhibit no abrupt changes in slope denoting skip grading, scalping of certain sizes, or other irregularities which would be detrimental to the proper functioning of the drain.

#### 3.2.1.2 Sampling and Testing

Sampling and testing of the drain material shall be performed by the Contractor to determine compliance of the installed materials with specified requirements in conformance with ASTM C 131, ASTM C 136, and ASTM D 75. Sampling and testing shall be performed at regular intervals with at least three tests being made for drain materials. The location of after placement tests shall be as directed.

## 3.3 PROTECTION

The Contractor shall take all necessary precautions to avoid damage to the completed subdrainage system from the movement of equipment during placing and compacting operations of fill material.

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## SECTION 02710

## BITUMINOUS-STABILIZED BASE COURSE, SUBBASE, OR SUBGRADE

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 75	(1987; R 1997) Sampling Aggregates
ASTM D 140	(2000) Sampling Bituminous Materials
ASTM D 490	(1992) Road Tar
ASTM D 977	(1998) Emulsified Asphalt
ASTM D 979	(1996) Sampling Bituminous Paving Mixtures
ASTM D 1556	(2000) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(2000) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu.m.))
ASTM D 1883	(1999) CBR (California Bearing Ratio) of Laboratory-Compacted Soils
ASTM D 2027	(1976; R 1997) Cutback Asphalt (Medium-Curing Type)
ASTM D 2172	(1995) Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
ASTM D 2922	(1996el) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(1988; R 1996el) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

ASTM D 4318

(2000) Liquid Limit, Plastic Limit, and  
Plasticity Index of Soils

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

### SD-03 Product Data

Plant, Equipment, Machines, and Tools; G, RE.

Mix Design; G, RE.

List of proposed equipment to be used in performance of construction work, including descriptive data. Contractor to submit mix design at least 30 calendar days before it is to be used.

Source of Bituminous Material; G, RE.

Operation of Aggregate Sources; G, RE.

Notification upon selection of bituminous material and aggregate sources.

Waybills and delivery tickets; G, RE.

Copies of waybills and delivery tickets during the progress of the work. Certified waybills and delivery tickets for all materials actually used.

### SD-04 Samples

Bituminous Material; G, RE.

Bituminous material used in the job.

### SD-06 Test Reports

Sampling and Testing; G, RE.

Calibration curves and related test results, prior to using the device or equipment being calibrated. Copies of field test results within 24 hours after the tests are performed. Certified copies of test results, not less than 30 days before material is required for the work.

## 1.3 UNIT PRICES

### 1.3.1 Waybills and Delivery Tickets

Copies of waybills or delivery tickets shall be submitted during the progress of the work. Before the final payment is allowed, waybills and certified delivery tickets shall be furnished for all bituminous materials

and select materials used in the construction.

### 1.3.2 Measurement for Payment

#### 1.3.2.1 Bituminous Stabilization

Measurement will be by the square meter of work completed and accepted.

#### 1.3.2.2 Bituminous Material

Bituminous material to be paid for will be measured in the number of metric tons of the material used in the accepted work.

#### 1.3.2.3 Select Material

Select material will be measured by the metric ton of material placed and used in the completed and accepted stabilization. Measurement will not be made for select material that is wasted or used in work determined to be defective.

### 1.3.3 Basis for Payment

Bituminous stabilization, constructed and accepted, and the quantities of bituminous material and select material will be paid for at the respective contract unit prices. Payment will not be made for any material wasted, used for the convenience of the Contractor, unused or rejected, or for water used. Select material obtained from grading and excavation operations at the project site will not be paid for under this section but will be included for payment under other sections specifying grading and excavating. Separate payment will not be made for sanding or dusting the bituminous prime-coated surfaces. Costs for sanding or dusting will be included in the contract unit price for bituminous material.

## 1.4 DEGREE OF COMPACTION

Degree of compaction is expressed as a percentage of the maximum density obtained by the test procedure in accordance with ASTM D 1557, abbreviated in this specification as percent laboratory maximum density.

## 1.5 STOCKPILING MATERIALS

Select material, including approved material available from excavation and grading shall be stockpiled in the manner and at the locations designated. Before stockpiling material, the storage sites shall be cleared, drained, and leveled. Materials obtained from different sources shall be stockpiled separately.

## 1.6 PLANT, EQUIPMENT, MACHINES, AND TOOLS

### 1.6.1 General Requirements

Plant, equipment, machines, and tools used in the work shall be subject to approval and shall be maintained in a satisfactory working condition at all times. The equipment shall have the capability of producing the required

compaction, meeting grade controls, thickness control and smoothness requirements indicated.

#### 1.6.2 Bituminous Distributor

Distributor shall have pneumatic tires that prevent rutting, shoving, or otherwise damaging base surface or other layers in the pavement structure. Distributor shall be designed and equipped to spray bituminous material in a uniform double or triple lap at the specified temperature, at variable widths, and at readily determined and controlled rates from 0.15 to 6.5 liters per square meter with an allowable variation from the specified rate of plus or minus 5 percent and with a pressure range of 175 to 515 kPa. Distributor equipment shall include a separate power unit for the bitumen pump, full-circulation spray bars, tachometer, pressure gauges, volume-measuring devices, adequate heaters for heating of materials to the proper application temperature, a thermometer for reading temperature of tank contents, and a hand hose attachment suitable for applying bituminous material manually to areas inaccessible to the distributor. Distributor shall be equipped to circulate and agitate the bituminous material during the heating process.

#### 1.6.3 Straightedge

The Contractor shall furnish and maintain at the site, in good condition, one 3.05 meter (10 foot) straightedge for each bituminous paver, for use in the testing of the finished surface. Straightedge shall be made available for government use. Straightedges shall be constructed of aluminum or other lightweight metal and shall have blades of box or box-girder cross section with flat bottom reinforced to insure rigidity and accuracy. Straightedges shall have handles to facilitate movement on pavement.

#### 1.7 WEATHER LIMITATIONS

Bituminous material shall not be applied when the atmospheric temperature is less than 10 degrees C. Bituminous material shall not be applied to soils that are frozen or contain frost. If the temperature falls below 2 degrees C, completed bitumen-treated areas shall be protected against any detrimental effects of freezing.

#### 1.8 SOURCE OF BITUMINOUS MATERIAL

Notification of the selected source of bituminous material shall be submitted to the Contracting Officer within 15 days after the award of contract.

### PART 2 PRODUCTS

#### 2.1 MATERIALS

##### 2.1.1 Bituminous Material

Material used for bituminous seal, in the soil-bitumen mixture, and for prime coat shall be the same grade throughout and shall conform to one of the following:

## 2.1.1.1 Liquid Asphalt

ASTM D 2027 Grade RC-70.

## 2.1.1.2 Emulsified Asphalt

ASTM D 977 Type MS-2.

## 2.1.1.3 Tar

ASTM D 490 Grade RT-1.

## 2.1.2 Material to be Stabilized

Material to be stabilized shall consist of approved select material.

Select material shall conform to the following gradation:

Sieve Designation	Percentage by Weight Passing Square-Mesh Sieve
75 mm	100
12.5	100
9.5	90-100
4.75	55-85
2.36	32-67
0.30	7-27
0.075	2-10

The liquid limit shall be less than 40 and the plasticity index shall be less than 10 when tested in accordance with ASTM D 4318 . The fine and coarse aggregates, or a composite mixture, shall not show stripping in excess of 5 percent. If stripping occurs, the aggregate shall be rejected.

## 2.1.3 Water

Water shall be clean, fresh, and potable.

## 2.2 MIX DESIGN

Contractor shall develop and submit for approval a proposed mix design prior to stabilization work. Mix shall be developed using samples of the material to be stabilized. Mix design shall be capable of producing a CBR bearing value of 50 CBR in accordance with ASTM D 1883.

## PART 3 EXECUTION

## 3.1 BITUMINOUS MATERIAL MIX

Bituminous material, of the amount required for each application, shall be uniformly applied by a bituminous distributor within a temperature range of 160 to 174 degrees C, as directed. Areas inaccessible to or missed by the

distributor shall be properly treated with bituminous material, using the manually operated hose attachment. After mixing is completed, the proportions of the mixture shall be in accordance with the approved mix design. On the basis of dry weight, moisture shall be 0 percent plus or minus 1 percent when mixing is complete. When the stabilized course is constructed in more than one layer, the previously constructed layer shall be cleaned of loose and foreign matter by sweeping with power sweepers or power brooms, except that hand brooms may be used in areas where power cleaning is not practicable. Adequate drainage shall be provided during the entire construction period to prevent water from collecting or standing on the area to be stabilized or on pulverized, mixed, or partially mixed material.

### 3.2 OPERATION OF AGGREGATE SOURCES

Notification of the selected source of aggregate shall be submitted to the Contracting Officer within 15 days after the award of contract. Clearing, stripping, and excavating shall be the responsibility of the Contractor. The aggregate sources shall produce the quality of base course materials meeting these specification requirements in the specified time limits. Aggregate material shall be obtained from off-site sources. Aggregate sources on private lands shall be conditioned in agreement with local laws or authorities. Aggregate sampling for laboratory tests shall be taken in accordance with ASTM D 75.

### 3.3 PREPARATION OF AREAS TO BE STABILIZED

Area shall be cleaned of debris. Area will be inspected for adequate compaction and shall be capable of withstanding, without displacement, compaction specified for the soil-bitumen mixture. Debris and removed unsatisfactory in-place material shall be disposed of as directed.

#### 3.3.1 In-Place Material to be Stabilized

The entire area shall be graded and shaped to conform to the lines, grades, and cross sections shown prior to being processed. Soft or yielding areas shall be made stable before construction is begun.

#### 3.3.2 In-Place Materials to Receive Stabilized Course

Soft, yielding areas and ruts or other irregularities in the surface shall be corrected. Material in the affected areas shall be loosened and unsatisfactory material removed. Approved select material shall be added where directed. The area shall then be shaped to line, grade, and cross section, and shall be compacted to the specified density in accordance with Section 02300 EARTHWORK. Subbase course shall conform to Section 02722 AGGREGATE BASE COURSE. Entire surface shall then be sealed with bituminous material applied as specified. The seal shall be covered with sand and rolled lightly with a steel-wheel or rubber-tired roller.

#### 3.3.3 Select Material

Sufficient select material shall be utilized to provide the required thickness of the soil-bitumen layer after compaction and shall be processed



to meet the requirements specified before bituminous stabilization is undertaken.

### 3.4 GRADE CONTROL

Underlying material shall be excavated to sufficient depth for the required stabilized-course thickness so that the finish stabilized course with the subsequent surface course will meet the fixed grade. Line and grade stakes shall be provided as necessary for control. Grade stakes shall be placed in lines parallel to the centerline of the area under construction and suitably spaced for string lining. Finished and completed stabilized area shall conform to the lines, grades, cross section, and dimensions indicated.

### 3.5 MIXING OF MATERIALS

#### 3.5.1 Mixed-in-Place Method

##### 3.5.1.1 Scarifying and Pulverizing of Soil

Prior to the application of bituminous materials, the soil shall be scarified and pulverized to a depth of 150 mm. Scarification shall be controlled so that the layer beneath the layer to be stabilized is not disturbed. Depth of pulverizing shall not exceed the depth of scarification. Unless otherwise permitted, area scarified and pulverized shall not exceed the area that can be completed in 2 working days.

##### 3.5.1.2 Application of Water

Pulverized material shall be shaped to the cross section and grade indicated. Moisture content shall then be determined. Water shall be added in increments and each increment of water shall be partially incorporated in the mix to avoid concentration of water near the surface. After the last increment of water has been added, mixing shall be continued until the water is uniformly distributed throughout the mixture, including satisfactory moisture distribution along the edges of the section.

##### 3.5.1.3 Application of Bituminous Material

Rate of application of bituminous material for the soil-bitumen mixture shall be sufficient to meet the mix design amount of bitumen. Bituminous material shall be uniformly mixed with the soil by means of a blade grader or rotary mixer. If the bituminous material is applied in more than one increment, each application shall be partially mixed into the material as directed. After the required amount of bituminous material has been added to the loose material, the bituminous material and soil shall be thoroughly mixed by blading with a blade grader, rotary mixer, or other equipment suitable for mixing the soil and bitumen. Equipment, except that used for spreading and mixing operations, shall not pass over the freshly spread bituminous material.

##### 3.5.1.4 Traveling-Plant Method

The pulverized material shall be placed in windrows. The windrows shall be of sufficient size to cover a predetermined width to the indicated

compacted thickness. Traveling plant shall move at a uniform rate of speed and shall accomplish thorough mixing of the materials. Water and bituminous material may be delivered separately or together at a predetermined rate.

### 3.5.2 Central Plant Method

#### 3.5.2.1 Mixing

Loading and hauling select material from pits or stockpiles shall result in a uniform grade of each material being delivered to the central-mixing plant. Properly batched or proportioned aggregate and soil binder materials shall be fed into the mixing unit together with the bituminous material and the quantity of water needed to obtain the required optimum moisture content. Mixing shall be continued until a homogeneous mixture is obtained. Mixture shall be hauled to the job in trucks equipped with protective covers. Mixture shall be placed with mechanical spreaders.

#### 3.5.2.2 Placing

The mixed material shall be placed on the prepared subgrade or subbase in layers of uniform thickness with an approved spreader. When a compacted layer 150 mm or less in thickness is required, the material shall be placed in a single layer. When a compacted layer in excess of 150 mm is required, the material shall be placed in layers of equal thickness. No layer shall exceed 150 mm or be less than 80 mm when compacted. When compacted, the layers shall be true to the grades or levels required with the least possible surface disturbance. Where the base course is placed in more than one layer, the previously constructed layers shall be cleaned of loose and foreign matter by sweeping with power sweepers, power brooms, or hand brooms, as directed. Such adjustments in placing procedures or equipment shall be made as may be directed to obtain true grades, to minimize segregation and degradation, to adjust the water content, and to ensure an acceptable base course.

### 3.6 PLACEMENT AND COMPACTION

For plant-mixed, machine laid materials, compaction shall begin immediately following placement. Rolling shall begin at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Alternate trips of the roller shall be slightly different lengths. Displacement of materials shall not occur. Density of compacted mixture shall be at least 95 percent of laboratory maximum density. Areas inaccessible to rollers shall be compacted to the required density with mechanical tampers.

### 3.7 EDGES OF STABILIZED COURSE

For areas where plant-mixed stabilized material is placed in successive strips, 300 mm of the material from the outside edge of the previously placed strip shall be removed prior to placing the adjacent strip. For the shoulders of the stabilized areas, approved material shall be placed along the edges of the stabilized course to compact to the thickness of the course being constructed, or to the thickness of each layer in a

multiple-layer course. At minimum 300 mm (1 foot) width of the shoulder or previously placed strip shall be rolled and compacted simultaneously with the rolling and compacting of each layer of the stabilized course, as directed.

### 3.8 FINISHING

The surface of the top layer shall be finished to grade and cross section shown. Finished surface shall be uniform texture. Light blading during rolling may be necessary for the finished surface to conform to the lines, grades, and cross sections. If the surface becomes rough, corrugated, uneven in texture, or traffic-marked prior to completion, such unsatisfactory portion shall be scarified, reworked, relaid, or replaced as directed. If any portion of the course, when laid, becomes watersoaked for any reason, that portion shall be removed immediately, and the mix placed in a windrow and aerated until a moisture content within the limits specified is obtained; and then spread, shaped, and rolled as specified.

#### 3.8.1 Smoothness

The surface of each layer shall show no deviations in excess of 10 mm (3/8 inch) when tested with the straightedge. Deviations exceeding this amount shall be corrected by removing material and replacing with new material, or by reworking existing material and compacting, as directed.

#### 3.8.2 Thickness Control

Compacted thickness of the stabilized course shall be within 13 mm (1/2 inch) of the thickness indicated. Where measured thickness of the stabilized course is more than 13 mm (1/2 inch) deficient, such areas shall be corrected by scarifying, adding new material of proper gradation, reblading, and recompacting as directed. Where the measured thickness of the stabilized course is more than 13 mm (1/2 inch) thicker than indicated, the course shall be considered as conforming to the specified thickness requirements. Average job thickness shall be the average of all thickness measurements taken for the job, but shall be within 6 mm (1/4 inch) of the thickness indicated.

### 3.9 CONSTRUCTION JOINTS

At the end of each day's construction, a straight transverse construction joint shall be formed by cutting back into the completed work to form a true vertical face free of loose or shattered material. Material along construction joints not properly compacted shall be removed and replaced with soil-bitumen that is mixed, moistened, and compacted in accordance with this specification.

#### 3.10 PRIME COAT

Before dust settles on the area, a prime coat of bituminous material shall be applied to the finished surface. Bituminous material shall be uniformly applied at the rate of 0.22 to 0.91 liters per square meter. Bituminous material shall be protected by sanding or dusting the treated surface. Sand shall be uniformly applied at the rate of 3.5 to 4.5 kilograms per

square meter.

### 3.11 Sampling and Testing

Sampling and testing shall be performed by an approved commercial testing laboratory or by facilities furnished by the Contractor. Work requiring testing will not be permitted until the facilities have been inspected and approved. The first inspection will be at the expense of the Government. Costs incurred for any subsequent inspection required because of failure of the facilities to pass the first inspection will be charged to the Contractor. Tests shall be performed in sufficient numbers and at the locations and times directed to ensure that materials and compaction meet specified requirements. Certified copies of test results shall be furnished to the Contracting Officer.

#### 3.11.1 Field Density

Field in-place density shall be determined in accordance with ASTM D 2922. With use of ASTM D 2922, the calibration curves shall be checked, and adjusted if necessary, using the sand cone method as described in paragraph Calibration of the ASTM publication. ASTM D 2922 results in a wet unit weight of soil and when using this method, ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in ASTM D 3017. With use of ASTM D 2922, in-place densities shall be checked by ASTM D 1556 at least once per lift for each 400 square meter of stabilized material. Calibration curves and calibration test results shall be furnished within 24 hours of conclusion of the tests. At least one field density test shall be performed for each 200 square meters of each layer of stabilized material.

#### 3.11.2 Sieve Analysis

A minimum of 1 analysis shall be performed for each 1000 metric tons of material to be stabilized, with a minimum of 3 analyses for each day's run until the course is completed. When the source of materials is changed and/or deficiencies are found, the analysis shall be repeated and the material already placed shall be retested to determine the extent of unacceptable material. All in-place unacceptable material shall be replaced at no additional cost to the Government.

#### 3.11.3 Liquid Limit and Plasticity Index

One liquid limit and plasticity index shall be performed for each sieve analysis. Liquid limit and plasticity index shall be in accordance with ASTM D 4318.

#### 3.11.4 Extraction Test

Extraction tests shall be conducted in accordance with ASTM D 2172, to confirm the amount of bitumen and moisture in the mixture. One test shall be conducted for every 275 metric tons of mixture placed. Sampling shall be taken in accordance with ASTM D 979.

## 3.11.5 Smoothness Test

Measurements for deviation from grade and cross section shown shall be taken in successive positions parallel to the road centerline, with a straightedge. Measurements shall also be taken perpendicular to the road centerline at 15 meter intervals.

## 3.11.6 Thickness

Thickness of the stabilized course shall be measured at intervals which ensure 1 measurement for each 400 square meters of stabilized course. Measurements shall be made in 75 mm diameter test holes penetrating the stabilized course.

## 3.11.7 Bituminous Material

A sample of the bituminous material used shall be taken in accordance with ASTM D 140 under the supervision of the Contracting Officer. The sample will be retained by the Government.

## 3.12 MAINTENANCE

Stabilized area shall be maintained in a satisfactory condition until accepted by the Contracting Officer. Maintenance shall include immediate repairs to any defects and shall be repeated as often as necessary to keep the area intact. Defects shall be corrected as specified.

## 3.13 TRAFFIC

Completed portions of the soil-bitumen area may be opened to controlled traffic within 4 hours of completion of the course, if approved by the Contracting Officer.

-- End of Section --

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## DIVISION 02 - SITE WORK

## SECTION 02722

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## SECTION 02722

## AGGREGATE BASE COURSE

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 117	(1995) Materials Finer Than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 127	(1988; R 1993el) Specific Gravity and Absorption of Coarse Aggregate
ASTM C 128	(1997) Specific Gravity and Absorption of Fine Aggregate
ASTM C 131	(1996) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM D 75	(1987; R 1997) Sampling Aggregates
ASTM D 422	(1963; R 1998) Particle-Size Analysis of Soils
ASTM D 1556	(2000) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(2000) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu.m.))
ASTM D 2487	(2000) Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 4318	(2000) Liquid Limit, Plastic Limit, and

## Plasticity Index of Soils

ASTM E 11

(1995) Wire-Cloth Sieves for Testing  
PurposesSTATE OF NEVADA DEPARTMENT OF TRANSPORTATION (NDOT), MATERIALS  
TESTING DIVISION

NDOT T230C

(Rev C) Method of Test For Determining the  
Percent of Fractured Faces

## 1.2 DEFINITIONS

For the purposes of this specification, the following definitions apply.

## 1.2.1 Aggregate Base

Aggregate base course (ABC) is well graded, durable aggregate uniformly moistened and mechanically stabilized by compaction.

## 1.2.2 Degree of Compaction

Degree of compaction shall be expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-03 Product Data

Plant, Equipment, and Tools.

List of proposed equipment to be used in performance of construction work, including descriptive data.

Waybills and Delivery Tickets; G, RE.

Copies of waybills and delivery tickets during the progress of the work. Before the final statement is allowed, the Contractor shall file certified waybills and certified delivery tickets for all aggregates actually used.

## SD-06 Test Reports

Sampling and testing; G, RE.

Field Density Tests; G, RE.

Calibration curves and related test results prior to using the

device or equipment being calibrated. Copies of field test results within 24 hours after the tests are performed. Certified copies of test results for approval not less than 30 days before material is required for the work.

#### 1.4 SAMPLING AND TESTING

Sampling and testing shall be the responsibility of the Contractor. Sampling and testing shall be performed by a testing laboratory approved in accordance with Section 01451 CONTRACTOR QUALITY CONTROL. Work requiring testing will not be permitted until the testing laboratory has been inspected and approved. The materials shall be tested to establish compliance with the specified requirements; testing shall be performed at the specified frequency. The Contracting Officer may specify the time and location of the tests. Copies of test results shall be furnished to the Contracting Officer within 24 hours of completion of the tests.

##### 1.4.1 Sampling

Samples for laboratory testing shall be taken in conformance with ASTM D 75. When deemed necessary, the sampling will be observed by the Contracting Officer.

##### 1.4.2 Tests

The following tests shall be performed in conformance with the applicable standards listed.

###### 1.4.2.1 Sieve Analysis

Sieve analysis shall be made in conformance with ASTM C 117 and ASTM C 136.

Sieves shall conform to ASTM E 11. Particle-size analysis of the soils shall also be completed in conformance with ASTM D 422.

###### 1.4.2.2 Liquid Limit and Plasticity Index

Liquid limit and plasticity index shall be determined in accordance with ASTM D 4318.

###### 1.4.2.3 Moisture-Density Determinations

The maximum density and optimum moisture content shall be determined in accordance with ASTM D 1557.

###### 1.4.2.4 Field Density Tests

Density shall be field measured in accordance with ASTM D 1556. For the method presented in ASTM D 1556 the base plate as shown in the drawing shall be used.

###### 1.4.2.5 Wear Test

Wear tests shall be made on ABC course material in conformance with ASTM C 131.

#### 1.4.2.6 Fractured Faces

The percentage fractured faces will be determined in accordance with NDOT T230C.

#### 1.4.3 Testing Frequency

##### 1.4.3.1 Initial Tests

One of each of the following tests shall be performed on the proposed material prior to commencing construction to demonstrate that the proposed material meets all specified requirements when furnished. If materials from more than one source are going to be utilized, this testing shall be completed for each source.

- a. Sieve Analysis including 0.02 mm size material.
- b. Liquid limit and plasticity index.
- c. Moisture-density relationship.
- d. Wear.

##### 1.4.3.2 In Place Tests

Each of the following tests shall be performed on samples taken from the placed and compacted ABC. Samples shall be taken and tested at the rates indicated.

- a. Density tests shall be performed on every lift of material placed and at a frequency of one set of tests for every 250 square meters, or portion thereof, of completed area.
- b. Sieve Analysis including 0.02 mm size material shall be performed for every 500 metric tons, or portion thereof, of material placed.
- c. Liquid limit and plasticity index tests shall be performed at the same frequency as the sieve analysis.

#### 1.5 WEATHER LIMITATIONS

Construction shall be done when the atmospheric temperature is above 2 degrees C. When the temperature falls below 2 degrees C, the Contractor shall protect all completed areas by approved methods against detrimental effects of freezing. Completed areas damaged by freezing, rainfall, or other weather conditions shall be corrected to meet specified requirements.

#### 1.6 PLANT, EQUIPMENT, AND TOOLS

All plant, equipment, and tools used in the performance of the work will be subject to approval before the work is started and shall be maintained in satisfactory working condition at all times. The equipment shall be adequate and shall have the capability of producing the required

compaction, meeting grade controls, thickness control, and smoothness requirements as set forth herein.

## PART 2 PRODUCTS

### 2.1 AGGREGATES

The ABC shall consist of clean, sound, durable particles of crushed stone, crushed gravel, angular sand, or other approved material. ABC shall be free of lumps of clay, organic matter, and other objectionable materials or coatings. The portion retained on the 4.75 mm sieve shall be known as coarse aggregate; that portion passing the 4.75 mm sieve shall be known as fine aggregate.

#### 2.1.1 Coarse Aggregate

Coarse aggregates shall be angular particles of uniform density. When the coarse aggregate is supplied from more than one source, aggregate from each source shall meet the specified requirements and shall be stockpiled separately.

a. Crushed Gravel: Crushed gravel shall be manufactured by crushing gravels, and shall meet all the requirements specified below.

b. Crushed Stone: Crushed stone shall consist of freshly mined quarry rock, and shall meet all the requirements specified below.

##### 2.1.1.1 Aggregate Base Course

ABC coarse aggregate shall not show more than 50 percent loss when subjected to the Los Angeles abrasion test in accordance with ASTM C 131. The amount of flat and elongated particles shall not exceed 30 percent. A flat particle is one having a ratio of width to thickness greater than 3; an elongated particle is one having a ratio of length to width greater than 3. In the portion retained on each sieve specified, the crushed aggregates shall contain at least 50 percent by weight of crushed pieces having two or more freshly fractured faces with the area of each face being at least equal to 75 percent of the smallest midsectional area of the piece. When two fractures are contiguous, the angle between planes of the fractures must be at least 30 degrees in order to count as two fractured faces. Crushed gravel shall be manufactured from gravel particles 50 percent of which, by weight, are retained on the maximum size sieve listed in TABLE 1.

#### 2.1.2 Fine Aggregate

Fine aggregates shall be angular particles of uniform density. When the fine aggregate is supplied from more than one source, aggregate from each source shall meet the specified requirements.

##### 2.1.2.1 Aggregate Base Course

ABC fine aggregate shall consist of screenings, angular sand, crushed recycled concrete fines, or other finely divided mineral matter processed or naturally combined with the coarse aggregate.

### 2.1.3 Gradation Requirements

The specified gradation requirements shall apply to the completed base course. The aggregates shall have a maximum size of 25 mm and shall be continuously well graded within the limits specified in TABLE 1. Sieves shall conform to ASTM E 11.

TABLE 1. GRADATION OF AGGREGATES

Sieve Designation	Percentage by Weight Passing Square-Mesh Sieve
-----	
25.0 mm	100
19.0 mm	90-100
4.75 mm	35-65
1.18 mm	15-40
0.075 mm	2-10

NOTE 1: Particles having diameters less than 0.02 mm shall not be in excess of 3 percent by weight of the total sample tested.

NOTE 2: The values are based on aggregates of uniform specific gravity. If materials from different sources are used for the coarse and fine aggregates, they shall be tested in accordance with ASTM C 127 and ASTM C 128 to determine their specific gravities. If the specific gravities vary by more than 10 percent, the percentages passing the various sieves shall be corrected as directed by the Contracting Officer.

### 2.1.4 Liquid Limit and Plasticity Index

Liquid limit and plasticity index requirements shall apply to the completed course and shall also apply to any component that is blended to meet the required gradation. The portion of any component or of the completed course passing the 0.425 mm sieve shall be either nonplastic or have a liquid limit not greater than 25 and a plasticity index not greater than 5.

## PART 3 EXECUTION

### 3.1 GENERAL REQUIREMENTS

When the ABC is constructed in more than one layer, the previously constructed layer shall be cleaned of loose and foreign matter by sweeping with power sweepers or power brooms, except that hand brooms may be used in areas where power cleaning is not practicable. Adequate drainage shall be provided during the entire period of construction to prevent water from collecting or standing on the working area. Line and grade stakes shall be provided as necessary for control. Grade stakes shall be in lines parallel to the centerline of the area under construction and suitably spaced for string lining.

### 3.2 OPERATION OF AGGREGATE SOURCES

Aggregates shall be obtained from offsite sources.

### 3.3 STOCKPILING MATERIAL

Prior to stockpiling of material, storage sites shall be cleared and leveled by the Contractor. All materials, including approved material available from excavation and grading, shall be stockpiled in the manner and at the locations designated. Aggregates shall be stockpiled on the cleared and leveled areas designated by the Contracting Officer to prevent segregation. Materials obtained from different sources shall be stockpiled separately. Waybills and Delivery tickets are required for each load.

### 3.4 PREPARATION OF UNDERLYING COURSE

Prior to constructing the ABC, the underlying course or subgrade shall be cleaned of all foreign substances. At the time of construction of the ABC, the underlying course shall contain no frozen material. The surface of the underlying course or subgrade shall meet specified compaction and surface tolerances. The underlying course shall conform to Section 02300 EARTHWORK. Ruts or soft yielding spots in the underlying courses, areas having inadequate compaction, and deviations of the surface from the requirements set forth herein shall be corrected by loosening and removing soft or unsatisfactory material and by adding approved material, reshaping to line and grade, and recompact to specified density requirements. For cohesionless underlying courses containing sands or gravels, as defined in ASTM D 2487, the surface shall be stabilized prior to placement of the ABC.

Stabilization shall be accomplished by mixing ABC into the underlying course and compacting by approved methods. The stabilized material shall be considered as part of the underlying course and shall meet all requirements of the underlying course. The finished underlying course shall not be disturbed by traffic or other operations and shall be maintained by the Contractor in a satisfactory condition until the ABC is placed.

### 3.5 INSTALLATION

#### 3.5.1 Mixing the Materials

The coarse and fine aggregates shall be mixed in a stationary plant, or in a traveling plant or bucket loader on an approved paved working area. The Contractor shall make adjustments in mixing procedures or in equipment as directed to obtain true grades, to minimize segregation or degradation, to obtain the required water content, and to insure a satisfactory ABC meeting all requirements of this specification.

#### 3.5.2 Placing

The mixed material shall be placed on the prepared subgrade in a single layer of uniform thickness with an approved spreader. No layer shall exceed 200 mm or less than 75mm when compacted. The layer shall be so placed that when compacted it will be true to the grades or levels required with the least possible surface disturbance.

### 3.5.3 Grade Control

The finished and completed ABC shall conform to the lines, grades, and cross sections shown. Underlying material(s) shall be excavated and prepared at sufficient depth for the required ABC thickness so that the finished ABC with the subsequent surface course will meet the designated grades.

### 3.5.4 Edges of Base Course

Additionally, approved fill material shall be placed along the outer edges of ABC in sufficient quantities to compact to the thickness of the course being constructed allowing at least a 300 mm width of this material to be rolled and compacted. If this base course material is to be placed adjacent to another pavement section, then the layers for both of these sections shall be placed and compacted along this edge at the same time.

### 3.5.5 Compaction

Each layer of the ABC shall be compacted as specified with approved compaction equipment. Water content shall be maintained during the compaction procedure to within plus or minus 5 percent of the optimum water content determined from laboratory tests as specified in paragraph SAMPLING AND TESTING. Rolling shall begin at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Alternate trips of the roller shall be slightly different lengths. Speed of the roller shall be such that displacement of the aggregate does not occur. In all places not accessible to the rollers, the mixture shall be compacted with hand-operated power tampers. The Contractor shall make such adjustments in compacting or finishing procedures as may be directed to obtain true grades, to minimize segregation and degradation, to reduce or increase water content, and to ensure a satisfactory ABC. Any materials that are found to be unsatisfactory shall be removed and replaced with satisfactory material or reworked, as directed, to meet the requirements of this specification.

### 3.5.6 Thickness

Compacted thickness of the aggregate course shall be as indicated. No individual layer shall exceed 200 mm nor be less than 75 mm in compacted thickness. The total compacted thickness of the ABC course shall be within 13 mm of the thickness indicated. Where the measured thickness is more than 13 mm deficient, such areas shall be corrected by scarifying, adding new material of proper gradation, reblading, and recompacting as directed. Where the measured thickness is more than 13 mm thicker than indicated, the course shall be considered as conforming to the specified thickness requirements. Average job thickness shall be the average of all thickness measurements taken for the job, but shall be within 6 mm of the thickness indicated. The total thickness of the ABC course shall be measured at intervals in such a manner as to ensure one measurement for each 500 square meters of base course. Measurements shall be made in 75 mm diameter test holes penetrating the base course.



### 3.5.7 Finishing

The surface of the top layer of ABC shall be finished after final compaction by cutting any overbuild to grade and rolling with a steel-wheeled roller. Thin layers of material shall not be added to the top layer of base course to meet grade. If the elevation of the top layer of ABC is 13 mm or more below grade, then the top layer should be scarified to a depth of at least 75 mm and new material shall be blended in and compacted to bring to grade. Adjustments to rolling and finishing procedures shall be made as directed to minimize segregation and degradation, obtain grades, maintain moisture content, and insure an acceptable base course. Should the surface become rough, corrugated, uneven in texture, or traffic marked prior to completion, the unsatisfactory portion shall be scarified, reworked and recompactd or it shall be replaced as directed.

### 3.5.8 Smoothness

The surface of the top layer shall show no deviations in excess of 10 mm when tested with a 3.05 meter straightedge. Deviations exceeding this amount shall be corrected by removing material and replacing with new material, or by reworking existing material and compacting it to meet these specifications.

### 3.6 TRAFFIC

Completed portions of the ABC course may be opened to limited traffic, provided there is no marring or distorting of the surface by the traffic. Heavy equipment shall not be permitted except when necessary to construction, and then the area shall be protected against marring or damage to the completed work.

### 3.7 MAINTENANCE

The ABC shall be maintained in a satisfactory condition until the full pavement section is completed and accepted. Maintenance shall include immediate repairs to any defects and shall be repeated as often as necessary to keep the area intact. Any area of ABC that is damaged shall be reworked or replaced as necessary to comply with this specification.

### 3.8 DISPOSAL OF UNSATISFACTORY MATERIALS

Any unsuitable materials that must be removed shall be disposed of as directed. No additional payments will be made for materials that must be replaced.

-- End of Section --

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## SECTION 02741

## HOT-MIX ASPHALT (HMA) FOR ROADS

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 117	(1995) Materials Finer Than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 131	(1996) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM C 150	(1999a) Portland Cement
ASTM C 566	(1997) Total Evaporable Moisture Content of Aggregate by Drying
ASTM D 140	(2000) Sampling Bituminous Materials
ASTM D 422	(1963; R 1998) Particle-Size Analysis of Soils
ASTM D 995	(1995b) Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures
ASTM D 1461	(1985; R 1994) Moisture or Volatile Distillates in Bituminous Paving Mixtures
ASTM D 1559	(1989) Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
ASTM D 2172	(1995) Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
ASTM D 2489	(2000) Degree of Particle Coating of Bituminous-Aggregate Mixtures

ASTM D 2950	(1997) Density of Bituminous Concrete in Place by Nuclear Method
ASTM D 3381	(1992; R 1999) Viscosity-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 3666	(2000) Minimum Requirements for Agencies Testing and Inspecting Bituminous Paving Materials
ASTM D 4318	(2000) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 4867/D 4867M	(1996) Effect of Moisture on Asphalt Concrete Paving Mixtures
ASTM D 5444	(1998) Mechanical Size Analysis of Extracted Aggregate
ASTM D 6307	(1998) Asphalt Content of Hot Mix Asphalt by Ignition Method

## ASPHALT INSTITUTE (AI)

AI MS-2	(1997) Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types
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## STATE OF NEVADA DEPARTMENT OF TRANSPORTATION (NDOT), MATERIALS TESTING DIVISION

NDOT T230C	(Rev C) Method of Test For Determining the Percent of Fractured Faces
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## 1.2 DESCRIPTION OF WORK

The work shall consist of pavement courses composed of mineral aggregate and asphalt material heated and mixed in a central mixing plant and placed on a prepared course. HMA designed and constructed in accordance with this section shall conform to the lines, grades, thicknesses, and typical cross sections shown on the drawings. Each course shall be constructed to the depth, section, or elevation required by the drawings and shall be rolled, finished, and approved before the placement of the next course.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The "RE" designates that the Resident Office will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Quality Control Plan for hot-mix asphalt; G, RE.

The Contractor shall develop an approved Quality Control Plan for hot-mix asphalt. Hot-mix asphalt for payment shall not be produced until the quality control plan has been approved.

SD-03 Product Data

Waybills and Delivery Tickets.

Waybills and delivery tickets submitted during progress of the work.

SD-04 Samples

Asphalt Cement Binder.

Samples of the asphalt cement binder specified shall be submitted for approval not less than 14 days before start of the test section.

SD-05 Design Data

Bituminous Pavement Mix Design; G, RE.

Copy of Mix Design selected. Report to be submitted and signed by a Civil Engineer Licensed to Practice in the State of Nevada.

Job Mix Formula; G, RE.

Properties of Bituminous Pavement Mixture; G, RE.

The job mix formula and properties of bituminous pavement mixture shall be submitted in writing by the Contractor for approval at least 14 days prior to the start of paving operations.

SD-06 Test Reports

Asphalt Content.

Aggregate Gradation.

Aggregate Moisture.

Temperatures.

Moisture Content of Mixture.

Laboratory Air Voids, Marshall Stability and Flow.

In-place Density.

Thickness.

Grade Conformance and Surface Smoothness.

Copies of test results. Reports to be submitted and signed by a Civil Engineer Licensed to Practice in the State of Nevada.

Asphalt Cement Binder.

Copies of test data indicating grade certification shall be provided by the supplier at the time of delivery of each load to the mix plant. Copies of these certifications shall be submitted to the Contracting Officer.

Aggregates; G, RE.

All aggregate test results and samples shall be submitted to the Contracting Officer at least 14 days prior to start of construction.

QC Monitoring; G, RE.

QC test results.

SD-07 Certificates

Testing Laboratory; G, RE.

Certification of compliance.

Plant Scale Calibration Certification.

Certificate of the testing laboratory, certification of compliance, and plant scale calibration certification.

#### 1.4 ASPHALT MIXING PLANT

Plants used for the preparation of hot-mix asphalt shall conform to the requirements of ASTM D 995 with the following changes:

- a. Truck Scales. The asphalt mixture shall be weighed on approved certified scales at the Contractor's expense. Scales shall be inspected and sealed at least annually by an approved calibration laboratory. The plant scale shall have a valid plant scale calibration certification.
- b. Testing Facilities. The Contractor shall provide all necessary laboratory facilities for the Contractor's quality control testing and use of the Government for acceptance testing, as necessary.
- c. Inspection of Plant. The Contracting Officer shall have access at all times, to all areas of the plant for checking adequacy of equipment; inspecting operation of the plant; verifying weights, proportions, and material properties; checking the temperatures maintained in the preparation of the mixtures and for taking samples. The Contractor shall provide assistance as requested, for the Government to procure any desired samples.
- d. Storage Bins. Use of storage bins for temporary storage of hot-mix asphalt will be permitted as follows:



(1) The asphalt mixture may be stored in non-insulated storage bins for a period of time not exceeding 3 hours.

(2) The asphalt mixture may be stored in insulated storage bins for a period of time not exceeding 8 hours. The mix drawn from bins shall meet the same requirements as mix loaded directly into trucks.

#### 1.5 HAULING EQUIPMENT

Trucks used for hauling hot-mix asphalt shall have tight, clean, and smooth metal beds. To prevent the mixture from adhering to them, the truck beds shall be lightly coated with a minimum amount of paraffin oil, lime solution, or other approved material. Petroleum based products shall not be used as a release agent. Each truck shall have a suitable cover to protect the mixture from adverse weather. When necessary to ensure that the mixture will be delivered to the site at the specified temperature, truck beds shall be insulated or heated and covers (tarps) shall be securely fastened.

#### 1.6 ASPHALT PAVERS

Asphalt pavers shall be self-propelled, with an activated screed, heated as necessary, and shall be capable of spreading and finishing courses of hot-mix asphalt which will meet the specified thickness, smoothness, and grade. The paver shall have sufficient power to propel itself and the hauling equipment without adversely affecting the finished surface. The paver shall have a receiving hopper of sufficient capacity to permit a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed without segregation. The screed shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture.

#### 1.7 ROLLERS

Rollers shall be in good condition and shall be operated at slow speeds to avoid displacement of the asphalt mixture. The number, type, and weight of rollers shall be sufficient to compact the mixture to the required density while it is still in a workable condition. Equipment which causes excessive crushing of the aggregate shall not be used.

#### 1.8 STRAIGHTEDGE

The Contractor shall furnish and maintain at the site, in good condition, one 3.66 m straightedge for each bituminous paver. Straightedge shall be made available for Government use. Straightedges shall be constructed of aluminum or other lightweight metal and shall have blades of box or box-girder cross section with flat bottom reinforced to insure rigidity and accuracy. Straightedges shall have handles to facilitate movement on pavement.

#### 1.9 GRADE AND SURFACE-SMOOTHNESS REQUIREMENTS

Finished surface of bituminous courses shall conform to gradeline and elevations shown and to surface smoothness requirements specified.

#### 1.9.1 Plan Grade

The grade of the completed surface shall not deviate more than 15.2 mm from the plan grade.

#### 1.9.2 Surface Smoothness

When a 3.66 m straightedge is laid on the surface parallel with the centerline of the paved area or transverse from crown to pavement edge, the surface shall vary not more than 6.4 mm from the straightedge.

#### 1.10 GRADE CONTROL

Lines and grades shall be established and maintained by means of line and grade stakes placed at site of work. Elevations of bench marks used by the Contractor for controlling pavement operations at the site of work will be determined, established, and maintained by the Government. Finished pavement elevations shall be established and controlled at the site of work by the Contractor in accordance with bench mark elevations furnished by the Contracting Officer.

#### 1.11 WEATHER LIMITATIONS

The hot-mix asphalt shall not be placed upon a wet surface or when the surface temperature of the underlying course is less than specified in Table 1. The temperature requirements may be waived by the Contracting Officer, if requested; however, all other requirements, including compaction, shall be met.

Table 1. Surface Temperature Limitations of Underlying Course

<u>Mat Thickness, mm</u>	<u>Degrees C</u>
75 or greater	4
Less than 75	7

#### PART 2 PRODUCTS

##### 2.1 AGGREGATES

Aggregates shall consist of stone, crushed stone, gravel, crushed gravel, screenings, natural sand and mineral filler, as required. The portion of material retained on the 4.75 mm sieve is coarse aggregate. The portion of material passing the 4.75 mm sieve and retained on the 0.075 mm sieve is fine aggregate. The portion passing the 0.075 mm sieve is defined as mineral filler. All aggregate test results and samples shall be submitted to the Contracting Officer at least 14 days prior to start of construction.

##### 2.1.1 Coarse Aggregate

Coarse aggregate shall consist of sound, tough, durable particles, free from films of material that would prevent thorough coating and bonding with the asphalt material and free from organic matter and other deleterious substances. All individual coarse aggregate sources shall meet the following requirements:

a. The percentage of loss shall not be greater than 45 percent after 500 revolutions when tested in accordance with ASTM C 131.

b. The portion of the material larger than the 10 mm screen shall contain at least 75 percent particles having fractured faces when tested in accordance with NDOT T230C.

#### 2.1.2 Fine Aggregate

Fine aggregate shall consist of clean, sound, tough, durable particles. The aggregate particles shall be free from coatings of clay, silt, or any objectionable material and shall contain no clay balls. Fine aggregate shall have a plasticity index of 6 percent or less and a liquid limit of 35 percent or less when tested in accordance with ASTM D 4318.

#### 2.1.3 Mineral Filler

Mineral filler shall consist of Portland cement conforming to ASTM C 150 or shall be mechanically reduced rock with the following gradation.

<u>Grain size in mm</u>	<u>Percent Finer</u>
0.075	75-100
0.05	65-100
0.02	35-65
0.01	26-35
0.005	10-22

Grain size shall be determined in accordance with ASTM D 422.

#### 2.1.4 Aggregate Gradation

The combined aggregate gradation shall conform to the gradation specified in Table 2, when tested in accordance with ASTM C 136 and ASTM C 117, and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve or vice versa, but grade uniformly from coarse to fine.

Table 2. Aggregate Gradation

<u>Sieve Size, mm</u>	<u>Percent Passing by Mass</u>
12.5	100
9.5	90-100
4.75	55-85
2.36	32-67

Table 2. Aggregate Gradation

Sieve Size, mm	Percent Passing by Mass
0.30	7-27
0.075	2-10

## 2.2 ASPHALT CEMENT BINDER

Asphalt cement binder shall conform to ASTM D 3381 Table 2, Viscosity Grade AC-40. Test data indicating grade certification shall be provided by the supplier at the time of delivery of each load to the mix plant. Copies of these certifications shall be submitted to the Contracting Officer. The supplier is defined as the last source of any modification to the binder. The Contracting Officer may sample and test the binder at the mix plant at any time before or during mix production. Samples for this verification testing shall be obtained by the Contractor in accordance with ASTM D 140 and in the presence of the Contracting Officer. These samples shall be furnished to the Contracting Officer for the verification testing, which shall be at no cost to the Contractor. Samples of the asphalt cement binder specified shall be submitted for approval not less than 14 days before start of the test section.

## 2.3 MIX DESIGN

The Contractor shall develop the bituminous pavement mix design. The asphalt mix shall be composed of a mixture of well-graded aggregate, mineral filler if required, and asphalt material. The aggregate fractions shall be sized, handled in separate size groups, and combined in such proportions that the resulting mixture meets the grading requirements of the job mix formula (JMF). No hot-mix asphalt for payment shall be produced until a JMF has been approved. The hot-mix asphalt shall be designed using procedures contained in AI MS-2 and the criteria shown in Table 3. If the Tensile Strength Ratio (TSR) of the composite mixture, as determined by ASTM D 4867/D 4867M is less than 75, the aggregates shall be rejected or the asphalt mixture treated with an approved anti-stripping agent. The amount of anti-stripping agent added shall be sufficient to produce a TSR of not less than 75. If an antistrip agent is required, it shall be provided by the Contractor at no additional cost. Sufficient materials to produce 90 kg of blended mixture shall be provided to the Contracting Officer for verification of mix design at least 14 days prior to the start of construction.

### 2.3.1 JMF Requirements

The job mix formula and properties of bituminous pavement mixture shall be submitted in writing by the Contractor for approval at least 14 days prior to the start of paving operations and shall include as a minimum:

- a. Percent passing each sieve size.
- b. Percent of asphalt cement.

- c. Percent of each aggregate and mineral filler to be used.
- d. Asphalt viscosity grade.
- e. Number of blows of hammer per side of molded specimen.
- f. Laboratory mixing temperature.
- g. Lab compaction temperature.
- h. Temperature-viscosity relationship of the asphalt cement.
- i. Plot of the combined gradation on the 0.45 power gradation chart, stating the nominal maximum size.
- j. Graphical plots of stability, flow, air voids, voids in the mineral aggregate, and unit weight versus asphalt content as shown in AI MS-2.
- k. Specific gravity and absorption of each aggregate.
- l. Percent natural sand.
- m. Percent particles with 2 or more fractured faces (in coarse aggregate).
- n. Fine aggregate angularity.
- o. Tensile Strength Ratio (TSR).
- p. Antistrip agent (if required) and amount.
- q. List of all modifiers and amount used.

Table 3. Marshall Design Criteria

<u>Test Property</u>	<u>50 Blow Mix</u>
Stability, newtons minimum	*4450
Flow, 0.25 mm	8-18
Air voids, percent	3-5
TSR, minimum percent	75

\* This is a minimum requirement. The average during construction shall be significantly higher than this number to ensure compliance with the specifications.

### 2.3.2 Adjustments to Field JMF

The Laboratory JMF for each mixture shall be in effect until a new formula is approved in writing by the Contracting Officer. Should a change in sources of any materials be made, a new laboratory design shall be performed and a new JMF approved before the new material is used. The Contractor will be allowed to adjust the Laboratory JMF within the limits specified below to optimize mix volumetric properties with the approval of the Contracting Officer. Adjustments to the Laboratory JMF shall be applied to the field (plant) established JMF and limited to those values as shown. Adjustments shall be targeted to produce or nearly produce 4 percent voids total mix.

Table 4. Field (Plant) Established JMF Tolerances  
Sieves                      Adjustments (plus or minus), percent

12.5 mm	3
4.75 mm	3
2.36 mm	3
0.075 mm	1
Binder Content	0.4

If adjustments are needed that exceed these limits, a new mix design shall be developed. Tolerances given above may permit the aggregate grading to be outside the limits shown in Table 2; while not desirable, this is acceptable.

## PART 3 EXECUTION

### 3.1 PREPARATION OF ASPHALT BINDER MATERIAL

The asphalt cement material shall be heated avoiding local overheating and providing a continuous supply of the asphalt material to the mixer at a uniform temperature. The temperature of unmodified asphalts shall be no more than 160 degrees C when added to the aggregates. Modified asphalts shall be no more than 174 degrees C when added to the aggregates.

### 3.2 PREPARATION OF MINERAL AGGREGATE

The aggregate for the mixture shall be heated and dried prior to mixing. No damage shall occur to the aggregates due to the maximum temperature and rate of heating used. The temperature of the aggregate and mineral filler shall not exceed 175 degrees C when the asphalt cement is added. The temperature shall not be lower than is required to obtain complete coating and uniform distribution on the aggregate particles and to provide a mixture of satisfactory workability.

### 3.3 PREPARATION OF HOT-MIX ASPHALT MIXTURE

The aggregates and the asphalt cement shall be weighed or metered and introduced into the mixer in the amount specified by the JMF. The combined materials shall be mixed until the aggregate obtains a uniform coating of

asphalt binder and is thoroughly distributed throughout the mixture. Wet mixing time shall be the shortest time that will produce a satisfactory mixture, but no less than 25 seconds for batch plants. The wet mixing time for all plants shall be established by the Contractor, based on the procedure for determining the percentage of coated particles described in ASTM D 2489, for each individual plant and for each type of aggregate used.

The wet mixing time will be set to at least achieve 95 percent of coated particles. The moisture content of all hot-mix asphalt upon discharge from the plant shall not exceed 0.5 percent by total weight of mixture as measured by ASTM D 1461.

### 3.4 PREPARATION OF THE UNDERLYING SURFACE

The underlying surface shall be maintained in suitable condition for the placement of asphaltic pavement. Immediately before placing the hot mix asphalt, the underlying course shall be cleaned of dust and debris. The surface of the base course will be inspected for adequate compaction and surface tolerances specified in paragraph: GRADE AND SURFACE-SMOOTHNESS REQUIREMENTS. Unsatisfactory areas shall be corrected, prior to commencement of asphaltic pavement lay down operations.

### 3.5 TESTING LABORATORY

The laboratory used to develop the JMF shall meet the requirements of ASTM D 3666. A certification signed by the manager of the laboratory stating that it meets these requirements or clearly listing all deficiencies shall be submitted to the Contracting Officer prior to the start of construction.

The certification shall contain as a minimum:

- a. Qualifications of personnel; laboratory manager, supervising technician, and testing technicians.
- b. A listing of equipment to be used in developing the job mix.
- c. A copy of the laboratory's quality control system.
- d. Evidence of participation in the AASHTO Materials Reference Laboratory (AMRL) program.

### 3.6 TRANSPORTING AND PLACING

#### 3.6.1 Transporting

The hot-mix asphalt shall be transported from the mixing plant to the site in clean, tight vehicles. Deliveries shall be scheduled so that placing and compacting of mixture is uniform with minimum stopping and starting of the paver. Adequate artificial lighting shall be provided for night placements. Hauling over freshly placed material will not be permitted until the material has been compacted as specified, and allowed to cool to 60 degrees C. To deliver mix to the paver, the Contractor shall use a material transfer vehicle which shall be operated to produce continuous forward motion of the paver. Waybills and delivery tickets are to be submitted with each load.

### 3.6.2 Placing

The mix shall be placed and compacted at a temperature suitable for obtaining density, surface smoothness, and other specified requirements. Upon arrival, the mixture shall be placed to the full width by an asphalt paver; it shall be struck off in a uniform layer of such depth that, when the work is completed, it shall have the required thickness and conform to the grade and contour indicated. The speed of the paver shall be regulated to eliminate pulling and tearing of the asphalt mat. Unless otherwise permitted, placement of the mixture shall begin along the centerline of a crowned section or on the high side of areas with a one-way slope. The mixture shall be placed in consecutive adjacent strips having a minimum width of 3 m. The longitudinal joint in one course shall offset the longitudinal joint in the course immediately below by at least 300 mm; however, the joint in the surface course shall be at the centerline of the pavement. Transverse joints in one course shall be offset by at least 3 m from transverse joints in the previous course. Transverse joints in adjacent lanes shall be offset a minimum of 3 m. On isolated areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the mixture may be spread and luted by hand tools.

### 3.7 COMPACTION OF MIXTURE

After placing, the mixture shall be thoroughly and uniformly compacted by rolling. The surface shall be compacted as soon as possible without causing displacement, cracking or shoving. The sequence of rolling operations and the type of rollers used shall be at the discretion of the Contractor. The speed of the roller shall, at all times, be sufficiently slow to avoid displacement of the hot mixture and be effective in compaction. Any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall be corrected at once. Sufficient rollers shall be furnished to handle the output of the plant. Rolling shall continue until the surface is of uniform texture, true to grade and cross section, and the required field density is obtained. After the Contractor is assured of meeting grade and smoothness requirements, rolling shall be continued until all roller marks are eliminated and at least 95 percent of the laboratory maximum density has been achieved. To prevent adhesion of the mixture to the roller, the wheels shall be kept properly moistened but excessive water will not be permitted. In areas not accessible to the roller, the mixture shall be thoroughly compacted with hand tampers. Any mixture that becomes loose and broken, mixed with dirt, contains check-cracking, or is in any way defective shall be removed full depth, replaced with fresh hot mixture and immediately compacted to conform to the surrounding area. This work shall be done at the Contractor's expense. Skin patching will not be allowed.

### 3.8 JOINTS

The formation of joints shall be made ensuring a continuous bond between the courses and to obtain the required density. All joints shall have the same texture as other sections of the course and meet the requirements for smoothness and grade.



### 3.8.1 Transverse Joints

The roller shall not pass over the unprotected end of the freshly laid mixture, except when necessary to form a transverse joint. When necessary to form a transverse joint, it shall be made by means of placing a bulkhead or by tapering the course. The tapered edge shall be cut back to its full depth and width on a straight line to expose a vertical face prior to placing material at the joint. The cutback material shall be removed from the project. In both methods, all contact surfaces shall be given a light tack coat of asphalt material before placing any fresh mixture against the joint.

### 3.8.2 Longitudinal Joints

Longitudinal joints which are irregular, damaged, uncompacted, cold (less than 80 degrees C at the time of placing adjacent lanes), or otherwise defective, shall be cut back a minimum of 50 mm from the edge with a cutting wheel to expose a clean, sound vertical surface for the full depth of the course. All cutback material shall be removed from the project. All contact surfaces shall be given a light tack coat of asphalt material prior to placing any fresh mixture against the joint. The Contractor will be allowed to use an alternate method if it can be demonstrated that density, smoothness, and texture can be met.

## 3.9 CONTRACTOR QUALITY CONTROL

### 3.9.1 General Quality Control Requirements

The Contractor shall develop an approved Quality Control Plan for hot-mix asphalt. Hot-mix asphalt for payment shall not be produced until the quality control plan has been approved. The plan shall address all elements which affect the quality of the pavement including, but not limited to:

- a. Mix Design
- b. Aggregate Grading
- c. Quality of Materials
- d. Stockpile Management
- e. Proportioning
- f. Mixing and Transportation
- g. Mixture Volumetrics
- h. Moisture Content of Mixtures
- i. Placing and Finishing
- j. Joints

k. Compaction

l. Surface Smoothness

3.9.2 Testing Laboratory

The Contractor shall have access to a fully equipped asphalt laboratory. The laboratory shall meet the requirements as required in ASTM D 3666. Laboratory facilities shall be kept clean and all equipment shall be maintained in proper working condition. The Contracting Officer shall be permitted unrestricted access to inspect the Contractor's laboratory facility, to witness quality control activities, and to perform any check testing desired. The Contracting Officer will advise the Contractor in writing of any noted deficiencies concerning the laboratory facility, equipment, supplies, or testing personnel and procedures. When, in the opinion of the Contracting Officer, the deficiencies are serious enough to adversely affect test results, the incorporation of the materials into the work shall be suspended immediately and will not be permitted to resume until the deficiencies are corrected.

3.9.3 Quality Control Testing

The Contractor shall perform all quality control tests applicable to these specifications and as set forth in the Quality Control Program. The testing program shall include, but shall not be limited to, tests for the control of asphalt content, aggregate gradation, aggregate moisture, temperatures, moisture content of mixture, laboratory air voids, Marshall stability and flow, in-place density, thickness, grade conformance and surface smoothness. A Quality Control Testing Plan shall be developed as part of the Quality Control Program.

3.9.3.1 Asphalt Content

A minimum of two tests to determine asphalt content will be performed per 1000 metric tons of asphaltic concrete produced by one of the following methods: the extraction method in accordance with ASTM D 2172, Method A or B, the ignition method in accordance with the ASTM D 6307. For the extraction method, the weight of ash, as described in ASTM D 2172, shall be determined as part of the first extraction test performed at the beginning of plant production; and as part of every tenth extraction test performed thereafter, for the duration of plant production. The last weight of ash value obtained shall be used in the calculation of the asphalt content for the mixture.

3.9.3.2 Aggregate Gradation

Aggregate gradations shall be determined for each 1000 metric tons of asphaltic concrete produced from mechanical analysis of recovered aggregate in accordance with ASTM D 5444. For batch plants, aggregates shall be tested in accordance with ASTM C 136 using actual batch weights to determine the combined aggregate gradation of the mixture.

3.9.3.3 Aggregate Moisture

The moisture content of aggregate used for production shall be determined a minimum of once per shift in accordance with ASTM C 566.

#### 3.9.3.4 Temperatures

At least one measurement of asphaltic concrete temperature shall be taken in each hour, in which paving operations are being conducted. Additional tests at additional locations, to determine the temperature at the dryer, the asphalt cement in the storage tank, the asphalt mixture at the plant, and the asphalt mixture at the job site, may be required as directed by the Contracting Officer.

#### 3.9.3.5 Moisture Content of Mixture

The moisture content of the mixture shall be determined at least once per shift in accordance with ASTM D 1461 or an approved alternate procedure.

#### 3.9.3.6 Laboratory Air Voids, Marshall Stability and Flow

Mixture samples shall be taken at least once per 1000 metric tons and compacted into specimens, using 50 blows per side with the Marshall hammer as described in ASTM D 1559. After compaction, the laboratory air voids of each specimen shall be determined, as well as the Marshall stability and flow.

#### 3.9.3.7 In-Place Density

At least three cores will be recovered and tested for every 1000 square meters of pavement, or one day's production, whichever is smaller. Additional tests may be taken as required by the Contracting Officer. The Contractor may conduct any additional necessary testing to ensure the specified density is achieved. A nuclear gauge may be used to monitor pavement density in accordance with ASTM D 2950. Record sampling will be by use of cores as indicated above.

#### 3.9.3.8 Thickness

At least three cores will be recovered and tested for every 1000 square meters of pavement, or one day's production, whichever is smaller. Additional tests may be taken as required by the Contracting Officer.

#### 3.9.3.9 Grade Conformance and Surface Smoothness

The Contractor shall conduct the necessary checks to ensure the grade and smoothness requirements are met in accordance with paragraph GRADE AND SURFACE SMOOTHNESS REQUIREMENTS.

#### 3.9.3.10 Additional Testing

Any additional testing, which the Contractor deems necessary to control the process, may be performed at the Contractor's option.

#### 3.9.3.11 QC Monitoring

The Contractor shall submit all QC test results to the Contracting Officer on a daily basis as the tests are performed. The Contracting Officer reserves the right to monitor any of the Contractor's quality control testing and to perform duplicate testing as a check to the Contractor's quality control testing. At the completion of asphalt work the Contractor shall submit a certification of compliance indicating that the work is in compliance with this section.

#### 3.9.4 Action Required

##### 3.9.4.1 Asphalt Content

If there is a failure to meet the specified asphalt content production will cease and the Contracting Officer will be immediately notified. No additional paving will occur until adjustments to the plant and test results confirm that the specified asphalt is being supplied.

##### 3.9.4.2 Aggregate Gradation

When the amount passing any sieve is outside the specification limits, the aggregate shall be immediately resampled and retested. If there is another failure on any sieve, the fact shall immediately be reported to the Contracting Officer, and immediate steps shall be taken to rectify the situation.

##### 3.9.4.3 Aggregate Moisture Content

When the moisture content of the aggregates is outside specification requirements the aggregates shall be immediately resampled and retested. If there is another failure, the fact shall immediately be reported to the Contracting Officer, and immediate steps shall be taken to rectify the situation.

##### 3.9.4.4 Temperature

When the temperature of the bituminous mixture is outside specification requirements the mixture shall be immediately resampled and retested. If there is another failure, the fact shall immediately be reported to the Contracting Officer, and immediate steps shall be taken to rectify the situation. In no case will overheated or carbonized mixtures be allowed.

##### 3.9.4.5 Asphalt Properties

If there is a failure in any of the asphalt properties production will cease and the Contracting Officer will be immediately notified. No additional paving will occur until adjustments to the plant and test results confirm that the specified properties are being achieved.

##### 3.9.4.6 Density

When test results indicate lack of compaction additional specimens will be obtained as directed by the Contracting Officer. Based on the test results the Contractor will remove and replace the affected areas of pavement.

#### 3.9.4.7 Thickness

When test results indicate that the finished pavement is 6 mm less than the thickness shown on the drawings, additional samples will be taken to determine the extent of defective thickness. The area determined will be removed and replaced or may be overlaid. The overlay will be a minimum of 25 mm thick and will be placed to duplicate slopes and drainages of the original pavement. No skin patching will be allowed.

#### 3.9.5 Sampling

When directed by the Contracting Officer, the Contractor shall sample and test any material which appears inconsistent with similar material being produced, unless such material is voluntarily removed and replaced or deficiencies corrected by the Contractor. All sampling shall be in accordance with standard procedures specified.

#### 3.9.6 Reports

All results of tests conducted shall be reported as required. During periods requiring protection from weather, reports of pertinent temperatures or other relevant values shall be made daily. These requirements do not relieve the contractor of the obligation to report certain failures immediately as required in preceding paragraphs. Such reports of failures and the action taken shall be confirmed in writing in the routine reports. The Contracting Officer has the right to examine all Contractor Quality Control records.

-- End of Section --

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## SECTION 02748

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## SECTION 02748

## BITUMINOUS TACK AND PRIME COATS

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 140	(2000) Sampling Bituminous Materials
ASTM D 977	(1998) Emulsified Asphalt
ASTM D 2027	(1976; R 1997) Cutback Asphalt (Medium-Curing Type)
ASTM D 2995	(1993) Determining Application Rate of Bituminous Distributors

## 1.2 WAYBILLS AND DELIVERY TICKETS

Before the final statement is allowed, the Contractor shall file with the Contracting Officer certified waybills and certified delivery tickets for all bituminous materials used in the construction of the pavement covered by the contract. The Contractor shall not remove bituminous material from storage until the initial outage and temperature measurements have been taken. The delivery or storage units will not be released until the final outage has been taken by the Contracting Officer; nor shall the Contractor release the car or storage tank taken until the final outage has been taken by the Contracting Officer.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Sampling and Testing.



Sampling and testing shall be performed by an approved commercial testing laboratory or by facilities furnished by the Contractor. Copies of all test results for bituminous materials shall be submitted within 24 hours of completion of tests. Certified copies of the manufacturer's test reports indicating compliance with applicable specified requirements shall be submitted not less than 30 days before the material is required in the work.

#### SD-07 Certificates

Waybills and Delivery Tickets; G, RE.

Waybills and delivery tickets shall be submitted during progress of the work.

### 1.4 PLANT, EQUIPMENT, MACHINES AND TOOLS

#### 1.4.1 General Requirements

Plant, equipment, machines and tools used in the work shall be subject to approval and shall be maintained in a satisfactory working condition at all times. The equipment shall be adequate and shall have the capability of producing the results specified.

#### 1.4.2 Bituminous Distributor

The distributor shall have pneumatic tires of such size and number to prevent rutting, shoving or otherwise damaging the base surface or other layers in the pavement structure. The distributor shall be designed and equipped to spray the bituminous material in a uniform double or triple lap at the specified temperature, at readily determined and controlled rates with an allowable variation from the specified rate of not more than plus or minus 5 percent, and at variable widths. Distributor equipment shall include a separate power unit for the bitumen pump, full-circulation spray bars, tachometer, pressure gauges, volume-measuring devices, adequate heaters for heating of materials to the proper application temperature, a thermometer for reading the temperature of tank contents, and a hand hose attachment suitable for applying bituminous material manually to areas inaccessible to the distributor. The distributor shall be equipped to circulate and agitate the bituminous material during the heating process.

#### 1.4.3 Power Brooms and Power Blowers

Power brooms and power blowers shall be suitable for cleaning the surfaces to which the bituminous coat is to be applied.

#### 1.4.4 Storage Tanks

Tanks shall be capable of heating the bituminous material, under effective and positive control at all times to the required temperature. Heating shall be accomplished by steam coils, hot oil, or electricity. An armored thermometer shall be affixed to the tank so that the temperature of the bituminous material may be read at all times.

### 1.5 WEATHER LIMITATIONS

Bituminous coat shall be applied only when the surface to receive the bituminous coat is dry. Bituminous coat shall be applied only when the atmospheric temperature in the shade is 10 degrees C or above and when the temperature has not been below 2 degrees C for the 12 hours prior to application.

## PART 2 PRODUCTS

### 2.1 TACK COAT

Emulsified asphalt shall conform to ASTM D 977, Type SS-1h.

### 2.2 PRIME COAT

Cutback asphalt shall conform to ASTM D 2027, Grade MC-70.

## PART 3 EXECUTION

### 3.1 PREPARATION OF SURFACE

Immediately before applying the bituminous coat, all loose material, dirt, clay, or other objectionable material shall be removed from the surface to be treated. To assure a uniform spread of the bituminous coat, the portion of the subgrade, subbase, or base course prepared for treatment, if excessively dry, shall be lightly sprinkled with water immediately before the application as directed by the Contracting Officer. For previously constructed pavement, the contact surface shall be dry and clean at the time of treatment. Prior to application of the tack coat, an inspection of the area to be treated shall be made by the Contracting Officer to determine fitness of the area to receive the bituminous coating.

### 3.2 APPLICATION RATE

The exact quantities within the range specified, which may be varied to suit field conditions, will be determined by the Contracting Officer based on trials made by Contractor.

#### 3.2.1 Tack Coat

Bituminous material for the tack coat shall be applied in quantities of not less than 0.20 liter nor more than 0.70 liter per square meter of pavement surface.

#### 3.2.2 Prime Coat

Bituminous material for the prime coat shall be applied in quantities of not less than 0.70 liter nor more than 1.80 liters per square meter of pavement surface.

### 3.3 APPLICATION TEMPERATURE

#### 3.3.1 Viscosity Relationship

Asphalt application temperature shall provide an application viscosity between 20 and 120 square mm/sec, kinematic. The temperature viscosity relation shall be furnished to the Contracting Officer.

### 3.3.2 Temperature Ranges

The viscosity requirements shall determine the application temperature to be used. The following is a normal range of application temperatures:

Bituminous Material	Application Temperature
-----	-----
MC-70	120-220 degrees C
SS-1h	70-160 degrees C

### 3.4 APPLICATION

Following preparation and subsequent inspection of the surface, the bituminous coat shall be applied at the specified rate with uniform distribution over the surface to be treated. All areas and spots missed by the distributor shall be properly treated with the hand spray. Until the succeeding layer of pavement is placed, the surface shall be maintained by protecting the surface against damage and by repairing deficient areas at no additional cost to the Government. If required, clean dry sand shall be spread to effectively blot up any excess bituminous material. No smoking, fires, or flames other than those from the heaters that are a part of the equipment shall be permitted within 8 meters of heating, distributing, and transferring operations of bituminous material other than bituminous emulsions. All traffic, except for paving equipment used in constructing the surfacing, shall be prevented from using the underlying material, whether primed or not, until the surfacing is completed. The bituminous coat shall conform to all requirements as described herein. Waybills and delivery tickets are to be submitted during progress of the work. To obtain uniform application of the prime coat on the surface treated at the junction of previous and subsequent applications, building paper shall be spread on the surface for a sufficient distance back from the ends of each application to start and stop the prime coat on the paper. Immediately after application, the building paper shall be removed and destroyed.

### 3.5 CURING PERIOD

Following application of the bituminous material and prior to application of the succeeding layer of pavement, the bituminous coat shall be allowed to cure and to obtain evaporation of any volatiles or moisture. Prime coat shall be allowed to cure without being disturbed for a period of at least 48 hours or longer, as may be necessary to attain penetration into the treated course.

### 3.6 FIELD QUALITY CONTROL

Samples of the bituminous material shall be tested for compliance with the applicable specified requirements. A sample shall be obtained and tested

by the Contractor for every 1900 metric tons of bituminous material used.

### 3.7 SAMPLING AND TESTING

Sampling and testing shall be performed by an approved commercial testing laboratory or by facilities furnished by the Contractor. No work requiring testing will be permitted until the facilities have been inspected and approved.

#### 3.7.1 Sampling

The samples of bituminous material, unless otherwise specified, shall be in accordance with ASTM D 140. Sources from which bituminous materials are to be obtained shall be selected and notification furnished to the Contracting Officer within 15 days after the award of the contract.

#### 3.7.2 Calibration Test

The Contractor shall furnish all equipment, materials, and labor necessary to calibrate the bituminous distributor. Calibration shall be made with the approved job material and prior to applying the bituminous coat material to the prepared surface. Calibration of the bituminous distributor shall be in accordance with ASTM D 2995.

#### 3.7.3 Trial Applications

Before providing the complete bituminous coat, three lengths of at least 30 meters for the full width of the distributor bar shall be applied to evaluate the amount of bituminous material that can be satisfactorily applied.

##### 3.7.3.1 Tack Coat Trial Application Rate

Unless otherwise authorized, the trial application rate of bituminous tack coat materials shall be applied in the amount of 0.20 liters per square meter. Other trial applications shall be made using various amounts of material as may be deemed necessary.

##### 3.7.3.2 Prime Coat Trial Application Rate

Unless otherwise authorized, the trial application rate of bituminous materials shall be applied in the amount of 1.10 liters per square meter. Other trial applications shall be made using various amounts of material as may be deemed necessary.

#### 3.7.4 Sampling and Testing During Construction

Quality control sampling and testing shall be performed as required in paragraph FIELD QUALITY CONTROL.

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SECTION 02821

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## SECTION 02821

## FENCING, CHAIN-LINK

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 116	(1995) Zinc-Coated (Galvanized) Steel Woven Wire Fence Fabric
ASTM A 153/A 153M	(1998) Zinc-Coated (Hot Dip) on Iron and Steel Hardware
ASTM A 392	(1996) Zinc-Coated Steel Chain-Link Fence Fabric
ASTM A 491	(1996) Aluminum-Coated Steel Chain-Link Fence Fabric
ASTM A 780	(2000) Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings
ASTM A 824	(1995) Metallic-Coated Steel Marcellled Tension Wire for Use With Chain Link Fence
ASTM C 94/C 94M	(2000) Ready-Mixed Concrete
ASTM F 626	(1996a) Fence Fittings
ASTM F 883	(1997) Padlocks
ASTM F 900	(1994) Industrial and Commercial Swing Gates
ASTM F 1043	(1998a) Strength and Protective Coatings on Metal Industrial Chain-Link Fence Framework
ASTM F 1083	(1997) Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures

ASTM F 1184 (1994) Industrial and Commercial  
Horizontal Slide Gates

UNDERWRITERS LABORATORIES (UL)

UL 467 (1993; Rev thru Aug 1996) Grounding and  
Bonding Equipment

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-07 Certificates

Chain Link Fence; G, RE.

Statement, signed by an official authorized to certify on behalf of the manufacturer, attesting that the chain link fence and component materials meet the specified requirements.

PART 2 PRODUCTS

2.1 FENCE FABRIC

Fence fabric shall conform to the following:

2.1.1 Chain Link Fence Fabric

ASTM A 392, Class 2, zinc-coated steel wire with minimum coating weight of 610 grams of zinc per square meter of coated surface, or ASTM A 491, Type I, aluminum-coated steel wire. Fabric shall be fabricated of 9 gauge wire woven in 50 mm mesh. Fabric height shall be 1.8 m as shown. Fabric shall be twisted and barbed on the top selvage and knuckled on the bottom selvage.

2.1.2 Woven Wire and Wire Netting

Woven wire shall conform to ASTM A 116 No. 12-1/2 close mesh fence; size as indicated. Wire netting shall conform to ASTM A 116 heavy grade; size as indicated.

2.2 GATES

ASTM F 900 and/or ASTM F 1184. Gate shall be the type and swing shown. Gate frames shall conform to strength and coating requirements of ASTM F 1083 for Group IA, steel pipe, with external coating Type A, nominal pipe size (NPS) 1-1/2. Gate frames shall conform to strength and coating requirements of ASTM F 1043, for Group IC, steel pipe with external coating Type A or Type B, nominal pipe size (NPS) 1-1/2. Gate fabric shall be as specified for chain link fabric. Gate leaves more than 2.44 m wide shall have either intermediate members and diagonal truss rods or shall have

tubular members as necessary to provide rigid construction, free from sag or twist. Gate leaves less than 2.44 m wide shall have truss rods or intermediate braces. Gate fabric shall be attached to the gate frame by method standard with the manufacturer except that welding will not be permitted. Latches, hinges, stops, keepers, rollers, and other hardware items shall be furnished as required for the operation of the gate. Latches shall be arranged for padlocking so that the padlock will be accessible from both sides of the gate. Stops shall be provided for holding the gates in the open position.

## 2.3 POSTS

### 2.3.1 Metal Posts for Chain Link Fence

ASTM F 1083, zinc-coated. Group IA, with external coating Type A steel pipe. Group IC steel pipe, zinc-coated with external coating Type A or Type B and Group II, formed steel sections, shall meet the strength and coating requirements of ASTM F 1043. Group III, ASTM F 1043 steel H-section may be used for line posts in lieu of line post shapes specified for the other classes. Sizes shall be as shown on the drawings. Line posts and terminal (corner, gate, and pull) posts selected shall be of the same designation throughout the fence. Gate post shall be for the gate type specified subject to the limitation specified in ASTM F 900 and/or ASTM F 1184.

## 2.4 BRACES AND RAILS

ASTM F 1083, zinc-coated, Group IA, steel pipe, size NPS 1-1/4. Group IC steel pipe, zinc-coated, shall meet the strength and coating requirements of ASTM F 1043. Group II, formed steel sections, size 42 mm (1-21/32 inch), conforming to ASTM F 1043, may be used as braces and rails if Group II line posts are furnished.

## 2.5 WIRE

### 2.5.1 Tension Wire

Tension wire shall be Type I or Type II, Class 2 coating, in accordance with ASTM A 824.

## 2.6 ACCESSORIES

ASTM F 626. Ferrous accessories shall be zinc or aluminum coated. Truss rods shall be furnished for each terminal post. Truss rods shall be provided with turnbuckles or other equivalent provisions for adjustment. Tie wire for attaching fabric to rails, braces, and posts shall be 9 gauge steel wire and match the coating of the fence fabric. Miscellaneous hardware coatings shall conform to ASTM A 153/A 153M unless modified.

## 2.7 CONCRETE

ASTM C 94/C 94M, using 19 mm maximum size aggregate, and having minimum compressive strength of 21 MPa at 28 days. Grout shall consist of one part portland cement to three parts clean, well-graded sand and the minimum



amount of water to produce a workable mix.

## 2.8 PADLOCKS

ASTM F 883, Type PO1, Grade 2, Size 44 mm (1-3/4 inch). Padlocks shall be keyed alike and each lock shall be furnished with two keys.

## 2.9 GROUND RODS

Rods made of copper-clad steel shall conform to UL 467. Ground rods shall be not less than 19.1 mm (3/4 inch) in diameter and 3.048 m (10 feet) in length.

# PART 3 EXECUTION

## 3.1 INSTALLATION

Fence shall be installed to the lines and grades indicated. The area on either side of the fence line shall be cleared to the extent indicated. Line posts shall be spaced equidistant at intervals not exceeding 3 meters (10 feet). Terminal (corner, gate, and pull) posts shall be set at abrupt changes in vertical and horizontal alignment. Fabric shall be continuous between terminal posts; however, runs between terminal posts shall not exceed 152.4 meters (500 feet). Any damage to galvanized surfaces, including welding, shall be repaired with paint containing zinc dust in accordance with ASTM A 780.

## 3.2 EXCAVATION

Post holes shall be cleared of loose material. Waste material shall be spread where directed. The ground surface irregularities along the fence line shall be eliminated to the extent necessary to maintain a 50 mm clearance between the bottom of the fabric and finish grade.

## 3.3 POST INSTALLATION

### 3.3.1 Posts for Chain Link Fence

Posts shall be set plumb and in alignment. Except where solid rock is encountered, posts shall be set in concrete to the depth indicated on the drawings. Where solid rock is encountered with no overburden, posts shall be set to a minimum depth of 457 mm (18 inches) in rock. Where solid rock is covered with an overburden of soil or loose rock, posts shall be set to the minimum depth indicated on the drawing unless a penetration of 457 mm (18 inches) in solid rock is achieved before reaching the indicated depth, in which case depth of penetration shall terminate. All portions of posts set in rock shall be grouted. Portions of posts not set in rock shall be set in concrete from the rock to ground level. Posts set in concrete shall be set in holes not less than the diameter shown on the drawings. Diameters of holes in solid rock shall be at least 25 mm (1 inch) greater than the largest cross section of the post. Concrete and grout shall be thoroughly consolidated around each post, shall be free of voids and finished to form a dome. Concrete and grout shall be allowed to cure for 72 hours prior to attachment of any item to the posts.

### 3.4 RAILS

#### 3.4.1 Top Rail

Top rail shall be supported at each post to form a continuous brace between terminal posts. Where required, sections of top rail shall be joined using sleeves or couplings that will allow expansion or contraction of the rail.

#### 3.4.2 Bottom Rail

The bottom rail shall be bolted to double rail ends and double rail ends shall be securely fastened to the posts. Bolts shall be peened to prevent easy removal. Bottom rail shall be installed before chain link fabric.

### 3.5 BRACES AND TRUSS RODS

Braces and truss rods shall be installed as indicated and in conformance with the standard practice for the fence furnished. Horizontal (compression) braces and diagonal truss (tension) rods shall be installed on fences over 1.83 m (6 feet) in height. A center brace or 2 diagonal truss rods shall be installed on 3.66 m (12 foot) fences. Braces and truss rods shall extend from terminal posts to line posts. Diagonal braces shall form an angle of approximately 40 to 50 degrees with the horizontal. No bracing is required on fences 1.83 m (6 feet) high or less if a top rail is installed.

### 3.6 TENSION WIRES

Tension wires shall be installed along the top and bottom of the fence line and attached to the terminal posts of each stretch of the fence. Top tension wires shall be installed within the top 305 mm of the installed fabric. Bottom tension wire shall be installed within the bottom 152 mm (6 inches) of the installed fabric. Tension wire shall be pulled taut and shall be free of sag.

### 3.7 CHAIN LINK FABRIC

Chain link fabric shall be installed on the side of the post indicated. Fabric shall be attached to terminal posts with stretcher bars and tension bands. Bands shall be spaced at approximately 381 mm (15 inch) intervals. The fabric shall be installed and pulled taut to provide a smooth and uniform appearance free from sag, without permanently distorting the fabric diamond or reducing the fabric height. Fabric shall be fastened to line posts at approximately 381 mm (15 inch) intervals and fastened to all rails and tension wires at approximately 610 mm intervals. Fabric shall be cut by untwisting and removing pickets. Splicing shall be accomplished by weaving a single picket into the ends of the rolls to be joined. The bottom of the installed fabric shall be 50 mm plus or minus 13 mm above the ground.

### 3.8 GATE INSTALLATION

Gates shall be installed at the locations shown. Hinged gates shall be

mounted to swing as indicated. Latches, stops, and keepers shall be installed as required. Padlocks shall be attached to gates or gate posts with chains. Hinge pins, and hardware shall be welded or otherwise secured to prevent removal.

### 3.9 GROUNDING

Except as indicated below, metal fences that are electrically continuous with metal posts extending at least 600 mm into the ground require no additional grounding. Other fences shall be grounded on each side of every gate. Fences shall be grounded by means of ground rods every 300 to 450 m of length when fences are located in isolated places, and every 150 to 225 m when in proximity (30 m or less) to public roads, highways, and buildings. The connection to ground shall be made from the post where it is of metal and is electrically continuous with the fencing.

Metal fences and metal hand rail system (pipe safety railing) crossed by overhead powerlines in excess of 600 volts shall be grounded. Fences and metal hand rail system crossed by powerlines of 600 volts or more shall be grounded at or near the point of crossing and at distances not exceeding 45 m on each side of crossing. Ground conductor shall consist of No. 8 AWG solid copper wire. Grounding electrodes shall be 19 mm (3/4 inch) by 3.05 m (10 foot) long copper-clad steel rod. Electrodes shall be driven into the earth so that the top of the electrode is at least 152 mm (6 inches) below the grade. Where driving is impracticable, electrodes shall be buried a minimum of 305 mm deep and radially from the fence. The top of the electrode shall be not less than 0.6 m or more than 2.4 m from the fence. Ground conductor shall be clamped to the fence or railing and electrodes with bronze grounding clamps to create electrical continuity between fence posts, fence fabric, and ground rods.

-- End of Section --

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